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OUR IMMIGRANTS AND WHERE THEY GO.

DURING June alone 72,567 immigrants arrived at the ten principal United States ports, and during the year ending with June, 1880, the total number was 263,726, corresponding with 99,224 in 1878-9; the addition for remote ports not yet returned would probably be 20,000, making say 285,000 in 1879-80, as compared with 117,826 in 1878-9. In both cases merely transient visitors from foreign countries and American citizens returning are excluded from the count. Immigration is, therefore, two and a half times greater this year than last year, and it is likely to continue on a liberal scale, although not to reach the very large numbers of 1872 and 1873.

The number of returned passengers, citizens of the United States, is about 35,000 each year, and the alien passengers coming for business or pleasure, but not to stay, varies from 8,000 to 10,000 each year. All these are now carefully excluded from the computation of immigrants; although in former years, or at least previous to 1875, they were not so excluded.

A very interesting feature of the available facts in regard to immigration this year is the interior distribution of those who come, and the States or Territories where they finally settle. For six months ending with June last it is estimated that 116,000 immigrants passed to their destination through Chicago, the Chicago and Northwestern Railroad taking 31,500, and the Milwaukee and St. Paul road 25,000 to destinations northwestward, chiefly to Minnesota and Dakota. Next the Rockland and Alton road took 35,000 to Iowa and beyond; the Burlington road, 17,000 in the same direction, only the small number of 8,000 going southward along the line of the Illinois Central.

The same authority estimates the receipt by States as follows: Kansas, 15,000; the Pacific States, 15,000; Iowa, 14,000; Minnesota and Colorado, each 12,000; Wisconsin, Nebraska, and Dakota, each 11,000; Michigan, 3,000; and that 12,000 cross the border to Manitoba, most of whom return to the United States again. To Texas and the South only 4,000 are reported to go; and it is reported as being true of all the movement to localities for settlement that very few this year go to Texas and almost none to other Southern States. The real movement is westward from Chicago, and to Kansas and Colorado for whatever lies south of that line. It is also remarkable that very little of the much talked of emigration to Manitoba remains there; even the Icelandic colony has pulled up its tent poles and come over the border into the United States, abandoning its original location on Lake Winipeg.

Nearly half of the original immigration into New York and the seaboard cities remains for some time, more or less, in the vicinity of the ports of arrival, being persons who have friends in these cities, or skilled workmen employed in manufactures. The other half goes west to colonize, or to settle on lands, often in groups or companies, intending to remain together. Now, however, this colonial feature soon breaks up, and they mingle with all other elements of the population, as they should do. Most of those going to the extreme West have money or property, and soon become valuable citizens, the best off for many years being those now coming.—*Phila. Public Ledger.*

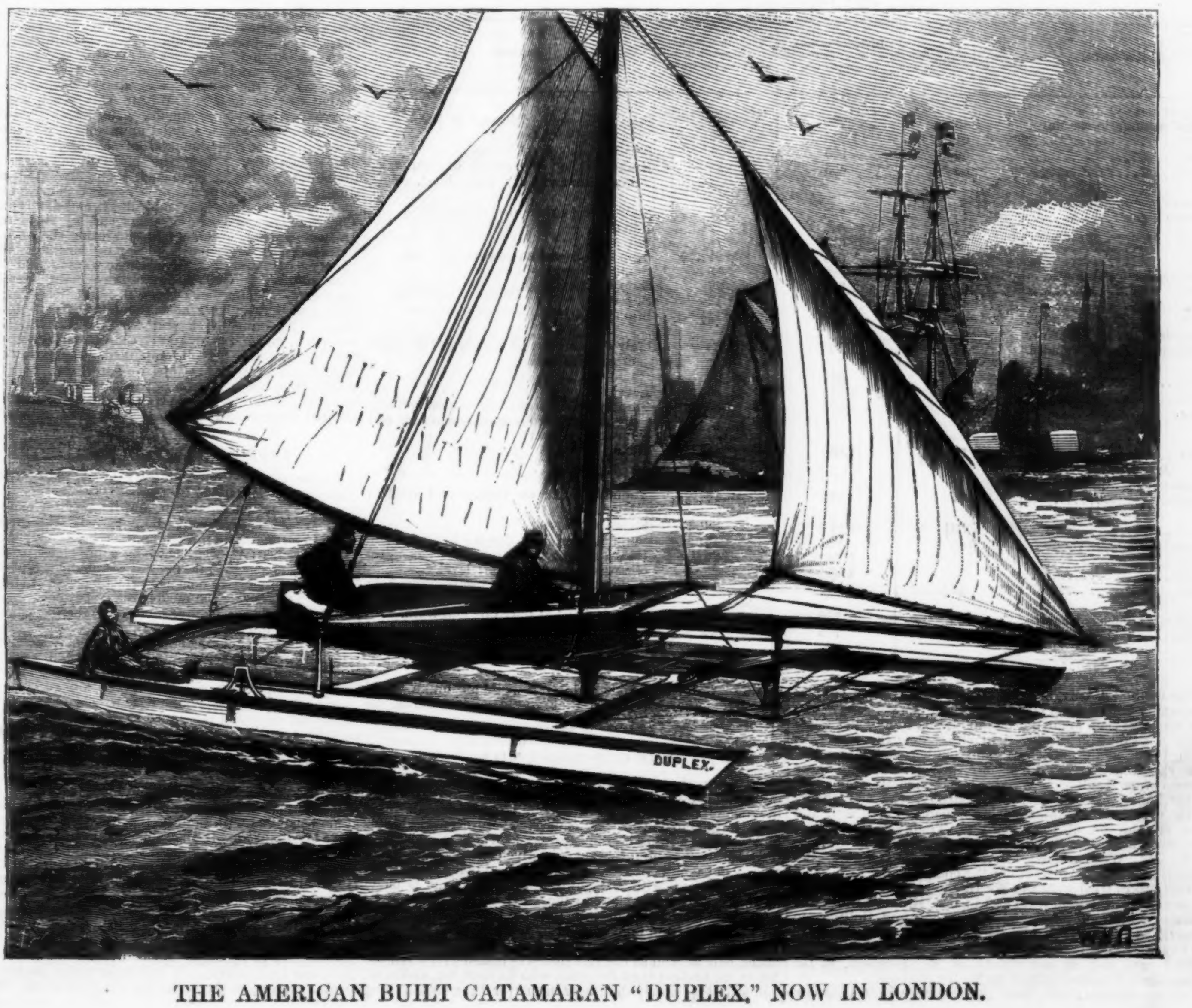
AN AMERICAN CATAMARAN IN LONDON.

THIS vessel, of a singularly novel design, was built in Rhode Island, United States of America, to the order of Mr. Henry N. Custance, who is honorary treasurer of the Corinthian Yacht Club. She may be seen in the Thames, at her moorings off Erith.

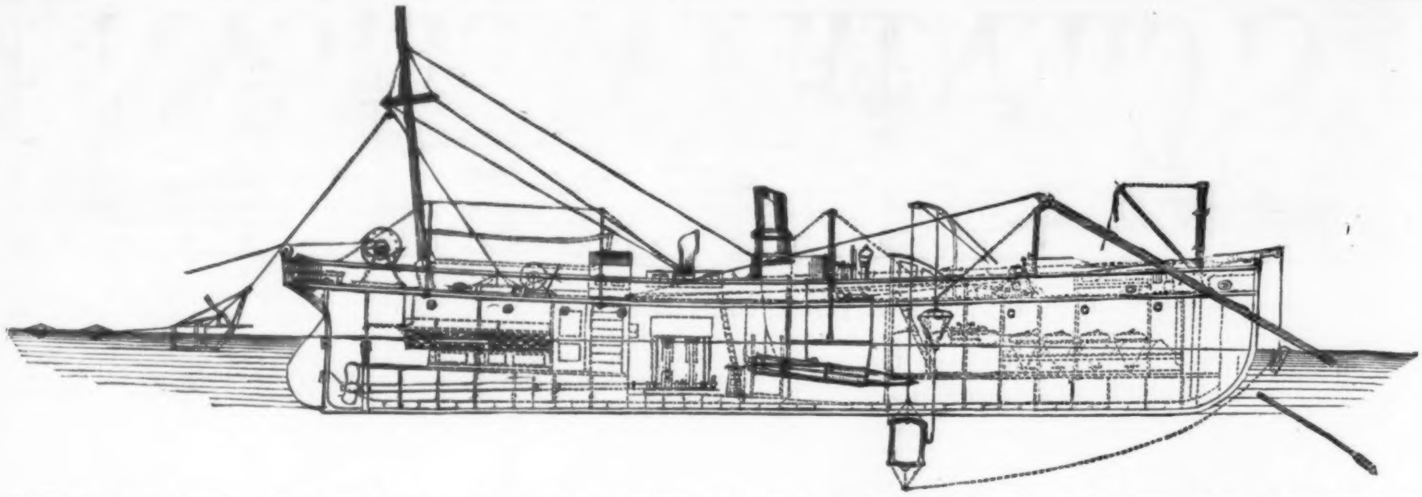
The Duplex, as she is called, is constructed with two hulls, each thirty-three feet long by two feet beam, and three feet deep, with a center board or sliding keel to each hull. They are fixed at a distance of twelve feet apart, and are joined together by truss girder beams, fore and aft, terminating in ball and socket shoulder joints bolted to the inside covering boards of each hull. On the top of the girder beams, which thus connect the extremities of the two hulls, rests a longitudinal truss girder, on which is supported the car, an oval platform in which the crew work the ship. From the longitudinal girder the mast rises through the car, and is stayed to it by a single shroud on either side, spreading to the extreme end of a frame made for the purpose, and bolted very strongly to the top of the car. Underneath the car are two stout lever beams, shackled to the longitudinal girder, and bolted very strongly to each hull. These levers keep each of the hulls in an upright position, whatever the strain may be on the rigging. The vessel is sloop rigged, and does not appear overburdened with sail. The steering is effected by a tiller fitted to work two rudders, one on each hull, simultaneously, and is so ingeniously contrived that while rounding a curve the inside rudder is always drawn over to a somewhat larger angle than the outside rudder. The highest rate of recorded speed that the Duplex has been able to make is at the rate of 23·1 miles per hour, with the tide, over the measured mile in the Lower Hope, during a fresh breeze and in calm water.—*Illustrated London News.*

NEW TORPEDO VESSEL.

THE Portuguese Government, in view of the protection of their magnificent harbor at Lisbon, and with comparatively limited resources at command, have with their usual tact sought to combine every specimen of torpedo warfare in one vessel, and we have pleasure in placing before our readers the plans and particulars of the Fulminante, built by the Thames Ironworks and Shipbuilding Company, London. This little vessel, seventy-five feet long, fifteen feet beam, and six feet draught, steaming eleven and a half miles, is fitted to carry the Whitehead torpedo, the Harvey torpedo, and the spar torpedo; she is also fitted to carry out a set of seven torpedo mines complete with the circuit closers, anchors, electric cables, etc. The Whitehead torpedo is worked from a frame and tumbler davits by means of a purchase leading to a small steam winch, which also works the spars, and lifts and lowers the torpedo mines, etc. The vessel is fitted with twin screws to facilitate keeping position while sinking the mines, and altogether forms a very complete description of vessel for the torpedo school practice, and will possibly constitute a type of vessel for our own as well as other navies. Captain P. da Fonseca Paz, of the Portuguese Royal Navy



THE AMERICAN BUILT CATAMARAN "DUPLEX," NOW IN LONDON.



TORPEDO VESSEL, FULMINANTE, FOR THE PORTUGUESE GOVERNMENT.—THE THAMES IRONWORKS AND SHIPBUILDING COMPANY, LONDON, BUILDERS.

has had the charge of arranging and inspecting all the details of her construction, the main features being the suggestion of Captain Freitas, the chief of the torpedo school of Portugal.

The mines may be laid and connected by the submarine cable with the shore, and the vessel then proceeds out of the harbor to attack the enemy with either Whitehead, Harvey, or spar torpedo, as best suited to accomplish her destructive mission.—*The Engineer.*

RECENT BRAKE TRIALS.

THE Lancashire and Yorkshire Railway Company, being desirous to obtain information concerning the relative merits of the Westinghouse, the Eames, and the Sanders automatic brakes, and Fay & Newall's hand brake, carried out a series of experiments with them on Thursday and Friday, July 15th and 16th.

The site selected was that portion of the line uniting Manchester with Edinburgh *via* Helifield, between Gisburn and Chatburn. The line has been only opened about a month; it is laid with 80 lb. steel rails, and is in perfect order. The up line to Manchester was reserved for the experimental train, the other, or down line, being worked double with a pilot engine and staff.

All the distances, etc., were taken by Captain Galton, assisted by Mr. Westinghouse and Mr. Captan, with the well known Westinghouse recording apparatus, which had been fitted up in a Lancashire and Yorkshire van by Mr. Budge.

The following table gives the broad facts of the trials, but it would be useless to attempt an analysis of the figures without the weights of the engines, which we have not obtained as yet. The trains each consisted of eight coaches and the experimental van, and the weight of the Eames train was 72 tons 18 cwt. 3 qrs.; that of the Sanders train 72 tons 2 cwt. 2 qrs.; and that of the Fay & Newall train 71 tons 14 cwt. 1 qr. The engines had all been weighed, but it seems that the tenders had been weighed empty, and so had to be weighed again, and we have not yet received the correct figures. We shall not be far wrong, however, if we put down the total weight of engine and train in all cases at about 130 tons.

One of the most noteworthy features about the trials is that the Sanders automatic brake was worked without any valves of any kind save those controlling it and under the hand of the guard and the engine driver. Simplicity cannot be carried further than this. Another was the admirable result obtained with the Fay and Newall brake, but it must be remembered that there were only four carriages to each guard, and that the guards stood at the wheel on the *qui vive*, and did their very best. But a guard might be away sorting parcels at one end of his van while his brake wheel was at the other, and much time would be lost before he could reach it.—*The Engineer.*

BRAKE EXPERIMENTS ON THE LANCASHIRE AND YORKSHIRE RAILWAY, BETWEEN GISBURN AND CHATBURN, JULY 15 AND 16, 1880.

Kind of brake.	Speed in miles per hour.	Distance in feet run after brake put on.	Time in seconds occupied in stopping the train.	Remarks.
Eames' automatic vacuum.	46	705	18	Stop from engine; down 1 in 100.
Ditto	61	1,205	23¼	Wet rails; level.
Ditto	59½	995	21	Slip stop; level.
Ditto	35	455	15	Brake put on by guard in rear van; steam kept on; dry rails; level.
Sanders' automatic vacuum brake	45	705	21	Stop from engine; down 1 in 100.
Ditto	45	625	12¾	Slip stop.
Ditto	48	675	18¾	Slip stop.
Ditto	39	625	21	Stop from rear van; steam kept on.
Westinghouse automatic	46	680	18	Stop from engine.
Ditto	65	1,380	27	Stop from engine.
Ditto	45	410	12	Slip stop.
Ditto	45	430	12½	Slip stop.
Lancashire and Yorkshire Westinghouse automatic.	52	1,235	28	Only 60 per cent. of weight of this train fitted with brakes.
Ditto	46	900	24	
Ditto	59	1,575	35¾	Level.
Ditto	46	1,175	33¾	Stop by guard from rear van on getting signal from front van; steam full on; down 1 in 100.
Ditto	55	1,650	41½	Ditto.
Fay & Newall's hand brake, put on by two guards	45	740	18¾	Vacuum brake on engine and tender; level.
Ditto	59½	1,810	38	Steam on; level.
Eames' automatic vacuum.	46	575	15½	Stop from engine; down 1 in 100.
Ditto	57	1,200	26	Guard's stop; steam on.
Ditto	53½	1,050	22	Guard's stop; steam on; level.
Ditto	43½	600	17	Automatic pipe only used; down 1 in 100.
Sanders' automatic vacuum.	46	730	21	Air admitted at only one end train.
Ditto	51	715	18	Slip stop; level.

The method of carrying out the trials was very simple. The trains started from Gisburn and ran toward Chatburn; one stop was then made on the incline of 1 in 100, and sometimes a second on the level; in either case the train was pushed back again to Gisburn, and another start was made. The experiments were, in a sense, private. Among those present were Mr. Barton Wright, locomotive superintendent of the Lancashire and Yorkshire Railway, who had charge of the experiments, Major Marindin, and Col. Yolland, and Geo. Hutchinson, of the Board of Trade. Mr. Stroudley, Mr. Macdonell, Mr. Dean, Mr. Bromley, Captain Galton, R.E., Mr. Westinghouse, Mr. Sanders, Mr. Eames, Mr. Spicer, and several directors of the company.

The brakes tried were the Westinghouse automatic, fitted to one Great Northern train and to one Midland train; the Eames vacuum automatic and the Sanders and Bolitho automatic vacuum brakes, and the Lancashire and Yorkshire or Fay & Newall brake. A very handsome luncheon was served each day at one o'clock by Mr. Jennison, in the goods shed at Gisburn fitted up for the purpose.

THE OLD HORSE MILL.

To comprehend the progress made in the business of millers in this State, it should be remembered that within the memory of persons who are by no means aged there were large portions of the country where even the water mill was still a thing of the future, and where the flour and the meal were ground by that primitive contrivance known as a "horse mill." Old-fashioned bread-makers will tell you sometimes with a sigh that no such flour is made nowadays as that furnished by the water mill. There may be even those who would declare that the best bread they ever ate was made from flour ground by horse power. But they would tell you, too, perhaps, that no turkey ever cooked tasted half so well as the one that was basted over a red-hot fire in the ancient open fireplace, with its back log, andirons, and swinging crane; that there has never been such a thing as real corn bread in existence since the art of making corn pone is lost, and various other statements respectable for antiquity, but utterly incredible in these days of elaborate cookery. Horse mills were not at all constructed upon exactly the same model, but the one to be described now was certainly as rude. The machinery to which the horses were attached consisted first of an upright shaft, which was simply a log hewed with an ax, and smoothed skillfully with the adze. The ends of this shaft were trimmed to a circular shape, so that it could turn easily when in place. A few feet from the ground the shaft was mortised for sweeps eight or ten feet in length, which extended outward in a horizontal direction, and to which the horses were attached. The horses walked in a circle, and, of course, turned the shaft slowly around. At the top of the shaft was a wooden wheel from sixteen to eighteen feet in diameter, which moved around just as slowly as the horses pleased. The under side of the rim of the wheel was fitted with cogs made of hickory wood, thoroughly seasoned, and dressed with tallow until they were capable of a polish as fine as mahogany. These cogs meshed in those of a much smaller wheel, which turned upon a horizontal shaft and communicated motion by means of the shaft to another set of cogwheels, and thus to the shaft which turned the upper millstone. In the mill alluded to the horse power was covered by a mere shed, with a roof of clapboards. The mill proper was a structure of hewed logs a story and a half in height. The millstones were placed in the loft, as the upper half story was called. There was no invention for carrying the grain from the ground up to the hopper. Men shouldered their sacks and carried them up the ladder. It is possible that in latter days a rope and pulley were substituted, but genius went no further. The mass of flour and bran together, after being ground, was carried to the bolter, which, as it appeared on the outside, was simply a closed bin about twelve feet in length. Within this chest was a frame covered with fine close muslin. The framework was hexagonal in shape, and was fixed upon a shaft which turned by means of a crank at one end of the bin. The bran and flour when turned into the bin fell upon the inside of the bolter, which, as it turned, gradually sifted out everything except the mere refuse. The fine flour went through the cloth first, then the middlings, and finally the shorts. The bran fell out at the other end of the bolter. The greatest care was necessary in separating the white flour.

Such a mill as this had plenty of business. Men came twenty miles, hauling their wheat in wagons, and sometimes were obliged to wait a day or two before they could get their grist. The miller's house at night was often crowded with guests, who were accommodated with beds upon the floor. The miller took toll for his work, one bushel in every ten, and if the customer did not have horses to turn the mill, half a bushel toll was added. One patron of the mill in question always came in a wagon drawn by a huge ox, which drew not in a yoke, but in harness. The patient animal was hitched to the sweep and did all the work usually allotted to three and four horses.—*Cincinnati Gazette.*

IMPROVED MOULDING MACHINE.

IN the common moulding machines, plates with an even surface were employed to produce the necessary pressure upon the sand for moulding; but these plates had the inconvenience of compressing those parts of the model which were in strong relief more than the others. Afterwards they tried to remedy the deficiency by using plates upon the interior surface of which the copy of the model was grooved; but it was impossible to construct the plates so that they corresponded exactly to the model; the consequence was that the deepest parts were compressed too much and the most elevated parts too little.

In the new machine of Messrs. Seboid & Neff, of Durlach (Baden), which is represented on next page, Figs. 3, 4, 5, 6, and 7, the casting box, *c*, is placed upon the metal plate, *a*, which carries the model, *b*, and then molten India-rubber or some other mass is poured in, which, after cooling, has a sufficient degree of resistance to transmit the pressure of the machine to the moulding sand. Thus one obtains a mould which exactly corresponds to the model, and can easily be removed after cooling; this mould then forms the pressure plate, *d*.

When an object is to be moulded, the casting box, *c*, is placed upon the metal plate, *a*, which carries the model; then it is filled with sand in the usual manner, and the surface is equalized. In the same manner the pressure plate, *d*, is put upon the ground, the mould being turned upward, the casting box, *c*, is placed upon it; this latter is also to be filled with sand, which, as in the former case, has to be equalized. This casting box, *c*, is now covered with a piece of sheet iron, the whole turned upside down, set upon the casting box, *c*, and the sheet iron is then removed. The position which the different parts occupy after this is done is indicated in Figure 5; (Figure 6 represents a similar casting box seen from below). It will be seen that the layer of sand which rests upon the model has everywhere the same thick-

ness; the pressure is consequently uniform, and a mould is obtained which is in all its parts equally compact.

In order to regulate the pressure according to the substance to be used, that position is given to the machine which is represented in Figures 3, 4, and 7. The plate, A, can move upward and downward in convenient guides which are fastened to the frame of the machine; upon this plate rests a sliding carriage, B, which carries the casting box, C, and this latter can be pressed by the plate, A, against the metal plate, K, which is fastened to the frame.

In the machine represented in Figure 3, the pressure acts from below, but, if necessary, the inverse method can be adopted. The ascending movement of the plate is produced by four toothed sectors which are brought into contact by the jointed links, E, and are governed by another toothed sector, F (Figure 4), whose movement is effected through the tooth wheel work, G, by means of the crank, H. The equilibrium of the plate, A, and of the load which rests upon it is secured by counter-weights, I, fastened to the axis of the sectors, D. The metal plate, K, is connected with the frame of the machine by means of a hinged joint in such a manner that it can be moved backward. When pressure is to be given this is maintained by means of straps which are stretched around two extremities of the frame. These straps are connected by means of joint, N, in such a way that a single push is sufficient to slacken them and thus to relax the pressure of the plate, K. This plate being movable, as above mentioned, casting boxes of different heights may be employed; and for this purpose the frame work is prolonged upward and furnished with holes in which the pivots of the plates can be placed. The hoops or straps, L, are arranged also so as to obtain the same result.

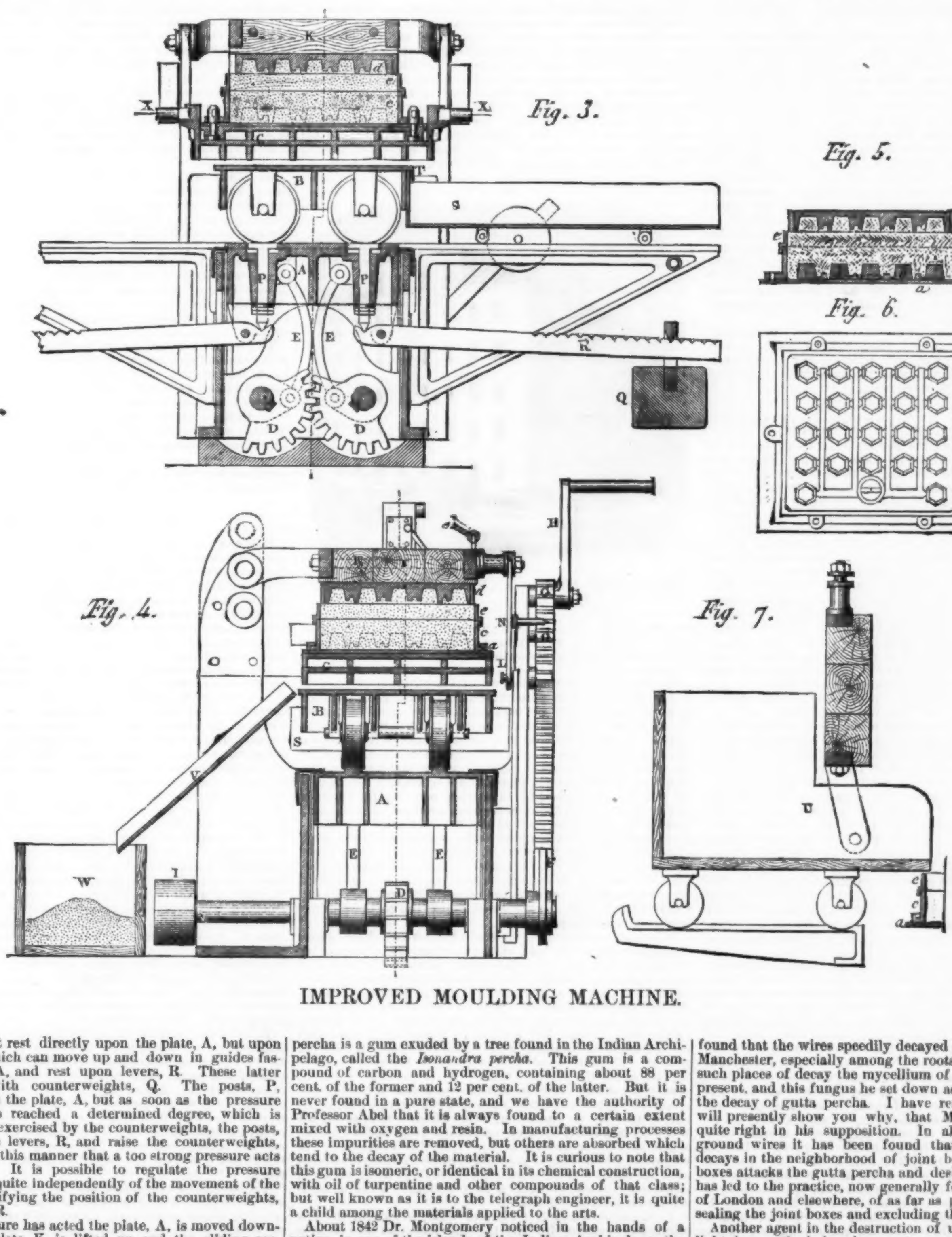
To be able to stop the pressure of the machine, when the mould has reached the determined degree of compactness, the following disposition has been adopted: The sliding carriage, B, does not rest directly upon the plate, A, but upon four posts, P, which can move up and down in guides fastened in plate, A, and rest upon levers, R. These latter are furnished with counterweights, Q. The posts, P, are lifted up with the plate, A, but as soon as the pressure of the mould has reached a determined degree, which is higher than that exercised by the counterweights, the posts, P, press upon the levers, R, and raise the counterweights, Q, preventing in this manner that a too strong pressure acts upon the mould. It is possible to regulate the pressure voluntarily, and quite independently of the movement of the plate, A, by modifying the position of the counterweights, Q, on the lever, R.

After the pressure has acted the plate, A, is moved downward again, the plate, K, is lifted up, and the sliding carriage is removed from under the mould, which is kept by the pivots, X, in the pillow blocks of the frame. By means of these pivots the mould can be placed so as to turn the pressure plate upward, and this can be loosened by a few strokes from below with a wooden hammer. To prevent sand from falling upon the rails, the sliding carriage, B, is provided with the box, S. During its upward movement the carriage is separated from this box, but by means of the bracket, T, it is united with it again when the carriage moves downward.

To render the task of filling the casting box with sand easy, a box which holds a great quantity of sand and moves upon rails is placed in front of the frame. When a mould is under pressure this sand box is removed. As often as a new casting box is placed in the machine the dividing carriage, B, is moved forward till plate, K, is lifted up and placed immediately upon the casting box. The sand from the carriage can then be introduced into the casting boxes and the surface equalized. The surplus of sand is removed through the channel, V, into the chest, W, which rests on the floor.

This machine is equally convenient for the moulding of large and small objects. To be able to use it to the greatest advantage two apparatus are employed simultaneously; the one is used for casting the lower mould, the other for casting the upper mould; both parts are then compressed against each other in a third central apparatus of special construction with which the machine is furnished.

Objects founded in these moulds are free from faults and satisfy all requirements. The machine itself can be easily managed; a single workman can handle it.



IMPROVED MOULDING MACHINE.

GUTTA PERCHA IN TELEGRAPHY.

By W. H. Preece.

During the past few years we have been very much disturbed by a peculiar decay of gutta percha, which has been rather difficult to account for. Every one knows that gutta percha is a gum exuded by a tree found in the Indian Archipelago, called the *Isonandra percha*. This gum is a compound of carbon and hydrogen, containing about 88 per cent. of the former and 12 per cent. of the latter. But it is never found in a pure state, and we have the authority of Professor Abel that it is always found to a certain extent mixed with oxygen and resin. In manufacturing processes these impurities are removed, but others are absorbed which tend to the decay of the material. It is curious to note that this gum is isomeric, or identical in its chemical construction, with oil of turpentine and other compounds of that class; but well known as it is to the telegraph engineer, it is quite a child among the materials applied to the arts.

About 1842 Dr. Montgomery noticed in the hands of a native, in one of the islands of the Indian Archipelago, the handle of a hatchet formed of a very peculiar material, which he was told became plastic in warm water, and capable of being moulded to any shape. He brought a specimen of it to England, and in 1845 brought it before a meeting of the Society of Arts, at which Dr. Siemens was present. The idea was at once suggested to Dr. Siemens that such material had a commercial value for telegraphic purposes. Experiments were made with it by Dr. Werner Siemens, in Berlin, and Faraday pronounced it as possessing electrical qualities of a high order, and a company was formed for bringing it into the market, since when it has been used in almost every conceivable form for electric and other purposes. I need not dwell on its application; my present object is to bring out its durability and behavior when applied to underground wires.

The gum is soluble in olive oil, benzine, turpentine, and other such spirits; it is attacked by ozone, creosote, and liquids of that kind. It combines with oxygen, and undergoes the ordinary process of rust, which proceeds with great alacrity in air, especially when also subjected to the influence of light. This combustion by oxygen is also assisted by intermittent exposure to moisture. In process of manufacture gutta percha becomes mechanically united with water, which evaporates on exposure to variations of temperature, and leaves the gum remaining in a dry and brittle condition. This condition led Mr. Edwin Clark to coat gutta percha with tape saturated with tar, in the belief that the tar would replace the water and keep the gum in its elastic state; but, unfortunately, tar contains creosote, which acts on gutta percha in a deteriorating manner, and so the evil remained.

In the years 1852-3-4, a great quantity of gutta percha covered wire was laid down, and some of the gentlemen now present had the responsibility and management of the work. These wires deteriorated, and among the many causes of deterioration was one frequently brought forward for discussion before the Institution of Civil Engineers, viz., the growth of fungus upon the gutta percha wires. Mr. Highton, an old telegraph engineer, who is no longer with us, found that the wires speedily decayed between London and Manchester, especially among the roots of oak trees; and in such places of decay the mycellium of a fungus was always present, and this fungus he set down as an active agent in the decay of gutta percha. I have reason to believe, and will presently show you why, that Mr. Highton was not quite right in his supposition. In all systems of underground wires it has been found that gutta percha wire decays in the neighborhood of joint boxes—the air in the boxes attacks the gutta percha and desiccates it. This fact has led to the practice, now generally followed in the streets of London and elsewhere, of as far as possible hermetically sealing the joint boxes and excluding the air.

Another agent in the destruction of underground wires is lightning, or the induced currents caused by lightning. The connecting wires between the Central Telegraph Station in London and the various railway termini are laid underground, and, when a current caused by lightning passes through the underground wires to find "earth," if a weak

spot in the percha comes in its path, it escapes through it, developing a fault and causing leakage. To remedy this, lightning protectors are now being fixed at the junction of the underground and overground wires.

Another enemy to the preservation of gutta percha exists in vermin; rats indulge freely in gutta percha, and are evidently only deterred from gnawing through it by shocks received on reaching the conducting wire. Mice have contributed their share of interruptions to gutta percha covered wires.

But the peculiar cause of deterioration in gutta percha that I want to bring before you to-night, is one due to the existence of an extremely minute insect—an animal so small that it easily escapes the naked eye. It happened a short time ago that simultaneously underground wires in different parts of the country showed novel signs of decay similar to each other. Not being satisfied with the reason attributed by the local officers, I resolved to examine the wires *in situ* for myself. I used my microscope to examine the dirt surrounding the wires, and soon perceived that an almost invisible white speck was really an insect of a very lively disposition, for as soon as it alighted on one place it jumped off to another. The presence of this animal assured me that I was on the track for tracing out the cause of decay in gutta percha wire; and, as the London street wires were affected, I invited Sir John Lubbock to examine a joint box, and he at once recognized the creature as *Templetonia crystallina*, belonging to the genus *Podura*, so-called because they are distinguished by a little sub-abdominal organ which might be described as a leg or a tail, but it is neither, but it has the peculiarity of giving to its owner the power of springing about with the activity of a flea. (Mr. Preece here pointed to a magnified drawing of the insect, and described its physical construction.) There can be no doubt that this depredator has a taste for gutta percha, and that it is the cause of decay in underground wires, because since its existence has been known it has always been found present at these peculiar points of decay.

On close examination of a specimen, a dark substance resembling percha can be seen in the animal's stomach, but that it is percha cannot well be proved, on account of the smallness of the creature. Microscopes and slides with specimens of this *Templetonia crystallina* are on the table, so that members may make themselves familiar with this new agent in the destruction of gutta percha covered wires. I have every reason to believe, from similarity of appearances, that this minute insect was the cause of the decay that Mr. Highton ascribed to the mycellium of a fungus. How is gutta percha to be cured from this effect? At present the only plan that has been practically tried, and which will probably be used for the purpose, is to protect the gutta percha with lead. When wires were laid underground in the early days they were covered with lead, but owing to its cost the practice was abandoned, though it seems clear now that for the proper protection of gutta percha in certain places lead will have to be again resorted to. By covering the wires with lead, we shall in my mind practically ward off the enemy by causing him to pass through that material before he can arrive at the percha.

I have made these remarks in the hope that the general question of the durability and protection of gutta percha may be fully discussed; and, as there are many present who have had great experience in that direction, I shall be glad if they will favor us with their remarks.

WASHBURN MILL "A," MINNEAPOLIS, MINN.

SUCH a national reputation has Minneapolis gained for its great milling interests, that now about the first request the average visitor makes on arriving, is to be conducted to the milling district, that he may see with his own eyes the great mills of which he has heard so much. When told that the capacity of these mills is at least 15,500 barrels of flour per day, in producing which some 70,000 bushels of wheat are consumed, and when shown flattering testimonials to the high standard of the flours from the highest authority, he wonders not at the renown attained by the fair "City of Mills." In the building up of this great industry in Minneapolis, probably no one man or corporation has been nearly so instrumental as ex-Governor C. C. Washburn, the names of whose mills—the "A," "B," and "C"—have become as household words, not only in the United States, but in many foreign lands. In view of these facts, perhaps, a description of the Washburn Mill "A," just completed, will be of interest to the readers of the *American Miller*.

As will be quite vividly remembered, especially by residents of Minneapolis, the old Washburn Mill "A" was destroyed by the terrible explosion on the evening of May 2, 1878. Since Mr. Washburn's attention was largely given to the immediate rebuilding of Washburn Mill "B," which was also partially wrecked by the explosion, the work of replacing the present mill "A," other than clearing away the debris and laying a part of the foundation, was delayed for nearly a year. This was done in order to carry on important experiments in the "B" mill, and determine what process should be employed in mill "A" to make it most successful and complete.

The present mill "A" occupies its former site, though taking up much additional space, its dimensions being 100x244 feet, and eight stories high. It is situated on a gentle slope, so that the rear end is one story taller than the front. On this account a view from the southeast corner gives one a better idea of the magnitude of the structure than from any other point. Constructed of blue limestone, pointed off in good shape, and being well proportioned, it presents a fine appearance. The walls at the base are five feet thick, and taper to three feet, at which thickness they are constructed to the third story, from which point they taper to twenty inches at the top. Over two and a quarter million feet of lumber and 15,000 perches of masonry have been used in its construction. It is said that this is the highest building in the State from which a view can be obtained, it being 158 feet from the cupola to the ground, on the river end.

Since we have taken a look at the exterior, we will now venture inside by way of the door on the lower or river end. Entering the first story or basement, we find extending for 236 feet the main line shafting, pit gearing, husk frames, etc. The motive power is furnished by an Ames-Boyden water-wheel, under a thirty-five foot head. On this floor are also forty wheat bins, each capable of containing two thousand bushels of wheat, making a total storage capacity of 80,000 bushels. These bins extend a few feet above the level of next floor above. Taking the Reedy elevator, it is but a moment before we reach the second or grinding floor. Here are located to the right ten run of four and a half foot French burrs, equipped with Behrns' patent exhaust; also ten of Gray's noiseless four roll roller mills, with porcelain rolls, and sixteen of Stout, Mills & Temple's smooth iron roller mills. The west end contains three rows of four roll roller mills, making a total of forty-two. These last-mentioned rolls are also of Messrs. Stout, Mills & Temple's make. Five reductions in all are made by these machines, the material after each reduction being elevated to the eighth floor, from which it is carried to the bolting and separating reels below. On this floor are also ten runs of Potts' patent ending stones. At the river end, fronting the canal, is a cosy little office, with a placard, "Head Miller," over the door, which is fitted up with all the conveniences that could possibly be desired by the ruling genius of such an establishment.

Again taking the elevator, we ascend to the third or packing floor, where are found in active operation seven Eureka flour packers. This floor is used almost wholly for packing and storing flour, but is divided into two distinct departments—one for patent and the other for baker's flour. The west end is used for packing bakers' brands, while the east end is allotted to patent flour. In the west end of this story are seven circular stock bins over the reduction rollers below. The "boots" of nearly all the elevators in the mill are located on this floor, but are suspended under the floor above, so that they do not interfere with the floor room below in the least.

The next floor we come to is the fourth, the west end of which contains eight No. 5 Richmond brush machines, six chilled iron four roller mills for middlings, twenty-five No. 2 Standard purifiers, and seventeen sections of the Washburn patent dust house, an invention of Mr. Washburn's for arresting dust in the air from the middlings purifiers, and keeping the mill free from dust. The east end is mainly occupied by twenty-four circular stock bins, four of which are to be used as receptacles of flour, and twenty for middlings, the latter being connected with the roller mills below. In this part of the mill a space has been set aside for a lunch room for the officers of the "A," "B," and "C" mills.

Taking another short ride on the elevator, we are landed on the fifth floor. The east end of this floor is occupied by four Woerner and five Standard purifiers, and the ends of four of the circular stock bins, which extend through the fourth story to the flour packers on the third. They are eight feet in diameter by twenty-four feet, and have a capacity for holding 285 barrels of flour each. Located on the west end, we find four double cylinder cockle machines, two centrifugal scalping reels, for ended wheat, two rows, twenty-five in all, of No. 2 Standard purifiers, flanked by seventeen more sections of the Washburn dust house. Two more circular flour bins that extend below to the packers have places here. It is in this part of this story that the upper end of the twenty-four inch six-ply rubber main driving belt, running about three thousand feet per minute, is found.

WASHBURN MILL "A," MINNEAPOLIS, MINN.

Passing to the sixth floor we are confronted at the west end by the lower half of eight ten-reel bolting chests, thirteen feet long, which are balanced on the opposite end by six more eight-reel chests, seventeen feet long, making a total of 128 reels on these two floors. Besides the reels on the west end of this floor, are sixteen Gray aspirators for the different reductions. Eight graders arranged in two sets, four of them being placed on a secondary floor above the others, two Sturtevant fans, used with the dust houses and centrifugal machines, and eleven sections of the patent dust house. In this part of the mill are also two Potts' wheat grading machines, and eight centrifugal reels, both of which machines are used in connection with the Potts' ending stones. On the east end of this floor there are, besides the bolting chests, the upper part of the middlings bins, ten sections more of the Washburn dust house, and a centrifugal flour mixing machine, with a capacity of one hundred barrels per hour.

Going up another story we reach the seventh floor, where are located the upper half of the bolting chests spoken of on the floor below, also the upper parts of the bran and screenings bins. Besides these, the machinery on this floor consists of four No. 3 Richmond grain separators, an aspirator, and four grading screens or sieves, each forty feet by twenty inches wide, which are covered with bolting cloths, and are used for grading or sizing middlings, each being capable of separating the middlings into ten different grades. They are used instead of reels for preparing the middlings for the purifiers below. It is here that we come across something that is seen in very few mills of this country. It is a miniature railway track, running from one end of the mill to the other, over which a hopper-shaped box car is pushed to carry middlings from the west end, where they are spouted into it, to the bins in the east. In the use of this device, it is claimed, quite a saving is effected over the usual way of conveying middlings by elevators or conveyors, where, at such a long distance, quite a waste would result from friction.

In the attic, which is forty feet wide, is located the line shaft and gearing for driving the elevators and bolting chests on the floor below. This floor is also the receptacle for all the elevator heads. Ascending another long flight of stairs, we find ourselves in the large cupola, from where a most enchanting view of the city can be obtained.

Now that we have partially described the location of the machinery, let us turn our attention to a few details as to the construction of the "A" mill. Like the majority of the mills now being built, it consists of two separate mills or sides, each being run independent of the other. As it now stands, only the northern half has been fitted up, giving it a capacity of fifteen hundred barrels of flour each twenty-four hours. But we are assured it will not be long ere the other half will be turning out another fifteen hundred barrels. Nothing has been left undone to make it a model of perfection, the best of workmanship and material being employed throughout its construction. Every detail has been watched with the closest scrutiny, producing work that would grace many of our finest residences. Especially is this true of the painting and finishing of the woodwork. And the millwright work, under the experienced eye of W. H. Odell, who had exclusive supervision of it, cannot be excelled. In the location of the machinery, the plans for which were drawn by Mr. William De la Barre, who has superintended the construction of the entire mill, the chief idea has been to keep the different machines together, so far as practicable, and we believe this has been almost perfectly accomplished, for one does not find a purifier and a roller mill here and there, but grouped together throughout the mill. Another noticeable feature is the absence of all upright shafts, except at the ends of the bolting chests, and one shaft to drive the cleaning machinery, belts being used in all other places. For precaution against fire, not only are pails and barrels of water placed within easy reach on all floors, but fire extinguishers are seen on all sides, while at each end of the building on every floor, ready for instant use, are one hundred feet of six inch hose connected with the city water works. The dividing line between the two sides of the building consists of a wide passage, bordered by the occasional posts that support the floor above, and unobstructed, save by the stairways at each end on every story. A system of electric bells and speaking tubes extends through the mill on both ends, so that the head miller or any employe can be summoned at a moment's notice from any part of the mill. On all the floors may be seen placards cautioning the employes against fire, and particularly urging and requiring them to keep the mill as free from dust "as a New England kitchen."

Much credit is due Mr. F. Wohlgenannt, the miller now in charge of the "A," who has given Mr. De la Barre most valuable assistance in the location of the machinery. Mr. H. C. Rau, now at work on the plans of the new mill being built at Cannon Falls, Minn., assisted in executing the plans of the "A."

As will be seen by our illustration, a double track runs through the very heart of the mill on a level with the packing floor, giving ample transportation facilities. The iron that composes the shafts, pulleys, gears, etc., amounts in the aggregate to 350,000 pounds, and was furnished by the North Star Iron Works, O. A. Pray, G. Menzel & Co., and Stout, Mills & Temple, of Dayton, Ohio. Among others who furnished machinery for the mill were E. P. Allis & Co., of Milwaukee, who put in the aspirators, air purifiers, some of the gearing and other machinery, and John Lucas, of Minneapolis, who furnished the elevator cups.

To give an idea of the immensity of the institution, we will state that the weight of the rollers and frames amounts to 170,000 pounds. The belting cost over $12,000 and the paint $3,000. Governor Washburn has purchased many thousand bushels of wheat, and is pushing the "A" mill to its fullest capacity, night and day. The mill is lighted throughout with gas jets, covered by dust-tight frames. The office, which is the most elegant in the city, is built on the north side, and is two stories high, the upper story being occupied by clerks, and the lower story forming the Governor's private office.—*American Miller.*

THE PORT OF ANTWERP.

BELGIUM is now celebrating the jubilee of her independence, and is inviting the world to witness the progress she has achieved in the National Exhibition opened a short time ago at Brussels. Though other towns of the kingdom may be more prominently represented at this Exhibition, probably none has derived as much advantage as Antwerp from the event which is commemorated.

Antwerp, the principal port of Belgium, has undergone many vicissitudes of fortune. In the thirteenth and fourteenth centuries it was in the height of prosperity; but during the latter half of the seventeenth and nearly the whole of the eighteenth century it was closed to large vessels by the treaty of Munster. It was at last opened again by the treaty of the Hague; and Napoleon I., having joined it to France, and, recognizing the importance of its position, established a naval arsenal there. The docks and quays, which had been commenced for military purposes, were, after the fall of Napoleon, delivered over to the corporation, who finished and devoted them to commercial objects. While, however, Belgium remained united to Holland, the growth of Antwerp was impeded by the natural preference of the Dutch Government for the ports of Amsterdam and Rotterdam. Since 1830 Antwerp has been free to follow an independent commercial career, and its development has been fostered by the Belgian Government, but the last restriction of a toll on its shipping was only removed in 1863. Flushing was established as a port by the Dutch Government for the purpose of diverting to Holland the growing trade of Antwerp, but it merely serves to illustrate the impossibility of forcing trade into any particular locality, even if favorably situated by nature. In fact, except the trade carried on by the steamers of the London, Chatham, and Dover Railway Company with Queensborough, Flushing is almost destitute of commerce, and is a port with ample accommodation, but no vessels.

Rotterdam and Amsterdam are the real rivals of Antwerp. Amsterdam has been placed in a more favorable condition by the execution of the North Sea Canal, whereby a shorter as well as a deeper route has been provided for its commerce than either the Zuider Zee or the North Holland Canal afforded. A deeper and more direct entrance channel has been attained for Rotterdam by the diversion of the Scheur branch of the Meuse into a cut across Hock van Holland; and the accommodation at Rotterdam is being enlarged by docks and quays on the Island of Feyenoord, opposite the town.

The Belgian Government and the corporation of Antwerp have, however, wisely determined that Antwerp shall not be behindhand in the race. Since 1856 continual additions or enlargements have been made to the docks. At the present time a considerable extension of the Kattendyk Dock is being made, and three new graving docks are approaching completion. Hydraulic machinery, provided by Sir William Armstrong & Co., has been erected, and provision made for its extended use. The electric light has

been also introduced for indicating at night the entrance to one of the locks. All these works have been carried out by the corporation, but the government are carrying out still more important quay works along the Scheldt. A great number of the larger vessels do not enter the docks, but discharge their cargoes alongside the quays. Some of the existing quays, however, are situated in shallow water; and their line is irregular, deflecting the current of the river and producing variations in its depth. To obtain deep water along the quays, and to regulate the course of the river, an entirely new line of quays has been designed, which will extend along the right bank of the river for the whole length in front of the town, from the site of the South Citadel estate to the docks at the northern end. The southern and northern portions of the quays will extend more or less into the river, while the central portion will cut into a projecting point of land; and, when completed, the quays will present a continuous curved face, concave to the river, along which the river will undoubtedly scour for itself a deeper channel, as it makes a sharp bend opposite the town, and the strongest current always follows the convex side of the stream.

Dredging will also be resorted to for insuring a sufficient depth, which the current will easily maintain. The construction of the quay wall is in progress, having been commenced at the southern end. The method of compressed air has been resorted to for building the foundations in the river. Large bottomless caissons, with plate-iron sides and roof, are built on shore, of a suitable length, wide enough for the foundations of the wall, and high enough for a man to stand upright in; this portion of the caisson constitutes the working chamber. Above the roof sides of plate iron are bolted on, and the whole caisson is floated into position between two barges. Tiers of stages are erected on an iron framework on each of the barges, and iron girders connect together the framework of the two barges above the caisson. The barges carry the compressed air machinery; the stages receive the material, and the girders support the caisson, when necessary, by means of chains.

The wall is commenced on the top of the roof of the working chamber, and continued till its weight is almost able to counterbalance the floatation of the caisson. The caisson is then floated up to its exact position and lowered at low water on to the bed of the river; the necessary weight of wall is then rapidly added to prevent its floating when the tide rises, and the wall is then built up so that its weight will keep the caisson in place when the working chamber is filled with compressed air. This having been done, compressed air is introduced into the working chamber through a central vertical tube passing down through the wall; and after the foundations have been prepared the chamber is filled with concrete, passed into it through four other vertical tubes. The wall having been then raised a little above low-water mark, the plates above the working chamber are unbolted and removed to serve for another length of wall, and the wall is built up in the ordinary manner. By this process no coffer dams are required, and the only portion of the caisson left in place is the ironwork which forms the working chamber. Some sections of the quay will have already emerged from the water, while the foundations of others are progressing. The quay wall will have a length of 3,800 yards, and its estimated cost, together with other contingent works, is £1,600,000, and the land which will be required to be taken is reckoned at £720,000. When the work is completed Antwerp will possess a magnificent range of quays, upon which it is proposed to place sidings, to erect sheds and cranes, and all other necessary appliances for trade. It is anticipated that the works will be finished in three years from the present time.

It is difficult to know which most to commend, whether the energy of the government in embarking on such an enterprise, or the skill with which the details of construction have been worked out by M. de Matthys, the engineer-in-chief, or the excellent manner in which the works are being carried out by the well-known French contractors, Messrs. Couvreuse et Hersent, formerly contractors for the Suez Canal. The wisdom of the step is fully justified by the marvelous increase in the trade of Antwerp within the last twenty years; for whereas in 1860 the tonnage of the vessels trading with the port was only 500,000 tons, it had risen in 1876 to five times that amount, viz., 2,500,000 tons; and it is so much on the increase that it is impossible to provide accommodation at a sufficient rate. Fortunately there is plenty of vacant space suitable for docks to the north of the existing docks, and a considerable relief will be afforded when the new quays are available. The principal trade of the port is with England, for which the return of 1876 gives 1,500,000 tons, amounting to three-fifths of the whole.

It appears, indeed, that though Antwerp seemed to have reached the zenith of her prosperity some centuries ago, a still more brilliant future is reserved for her. While the Brussels Exhibition indicates the prosperity and progress of Belgium in husbandry, arts, and manufactures, Antwerp bears witness to her commercial success.—*Universal Engineer*

THE INFLUENCE OF AGE UPON THE INTELLECT.

IN accordance with a promise made in a former issue, we give to-day a few facts regarding the ages at which many of the greatest writers and thinkers produced some of their most celebrated works; and we do so in order to put an end to the notion entertained by some cynics, misanthropes, and pseudo scientists, that the period of human decay begins between the ages of forty and forty-five. Our enumeration is not exhaustive of instances, neither does it include any but the works of literary men. It would be quite easy to give a very long list of soldiers, composers, statesmen, and so forth, who displayed the most marked vigor of mind and body long after the zenith of life had been passed.

"The richer a nature," says Carlyle, "the harder and slower its development. Two boys were once of a class in the Edinburgh Grammar School: John ever trim, precise, and dux; Walter ever slovenly, confused, and dolt. In due time John became Baillie John of Hunter Square, and Walter became Sir Walter Scott of the Universe. The quickest and completest of all vegetables is the cabbage." This slowly developed "Sir Walter Scott of the Universe" was thirty-four when he made his first draft of "Waverley," and forty-three when he rewrote and published it. Nearly every one of those tales which conferred immortality upon him was composed after he had reached the age of forty-six. He wrote the "Heart of Mid-Lothian" at forty-seven; the "Bride of Lammermoor, a Legend of Montrose," and "Ivanhoe" at forty-eight; the "Pirate" and "Peveril of the Peak" at fifty; the "Tales of the Crusaders" at fifty-four, and the "Chronicles of the Canongate" at fifty-seven. Carlyle was forty-two when he published the "French Revolution," the first work of his to which he formally put his name. The publication of this work was, it is true, delayed, owing to the burning of the MS. of one volume through the carelessness of Mrs. Taylor, to whom it had been loaned by John Stuart Mill, but if, that mishap had not occurred, Carlyle would have been over forty before his work could have appeared. His "Cromwell" was published when he was fifty; the first two volumes of his "Frederick the Great" when he was sixty-three, another two when he was sixty-seven, and the last two when he was sixty-nine. Swift was fifty-nine when he published "Gulliver's Travels," and certainly did no work on it before he was fifty-seven. Tennyson had reached fifty when his first idyls, "Enid," "Elaine," "Vivien," and "Guinevere" were published, and was about sixty-two when he completed the series with "Gareth and Lynette." Macaulay was forty-eight when he issued the first and second volumes of his History of England, and the third and fourth did not appear till he was fifty-five. Good as are the essays of his early manhood, they pale when compared with this work of his mature years. John Stuart Mill was fifty-three when his essay "On Liberty" was published, and fifty-six when he gave us that on "Utilitarianism." Milton was certainly more than fifty-four when he began to compose his "Paradise Lost." He was fifty-nine when he sold it to Simmons, the bookseller. It is currently believed that he received but five pounds. This is not true. Five pounds was the first payment. He afterward received five pounds more, and his wife, after his death, got an additional ten pounds. George Eliot (*née* Marian Evans, once Mrs. Lewes, and now Mrs. Cross), composed "Middlemarch" between the ages of forty-six and fifty-one, and since then "Daniel Deronda." Bacon was fifty-nine before he published his great work, the "Novum Organum." Cowper was over fifty when he wrote "John Gilpin" and the "Task;" and Defoe fifty-eight when he published "Robinson Crusoe." Darwin published his "Origin of Species" when fifty, and his "Descent of Man" when sixty-two. "A Tale of two Cities" appeared when Dickens was forty-eight; "Great Expectations" when he was forty-nine, and "Our Mutual Friend" when he was fifty-two. Grote wrote the larger part of his "History of Greece" between the ages of fifty-two and sixty-two, and Hallam occupied nearly the same period of life with his "Introduction to the Literature of Europe." Hobbes gave the world his immortal "Treatise on Human Nature" when sixty-two years old, and his "Leviathan" when sixty-three. The two works by which Thomas Hood has survived the grave, the "Bridge of Sighs" and the "Song of the Shirt," were composed when he was forty-six, and on a sick bed from which he never rose. Charles Reade published "Hard Cash" when forty-nine, "Griffith Gaunt" when fifty-two, "Foul Play" when fifty-four; "Put Yourself in His Place" when fifty-six, and "A Terrible Temptation" when fifty-seven. It would be easy to multiply instances of the fertility of British authors after the age of fifty years, but as our space will not admit of it (and our argument certainly does not demand it), we must pass to other nations.

Longfellow gave us "Hiawatha" when forty-eight; "Tales of a Wayside Inn" when fifty-six, and since then he has been as prolific as he has been excellent. We need only mention his translation of Dante's "Divina Commedia," and his exquisite poem, "Morituri Salutamus." "The Autocrat of the Breakfast Table" was published when Holmes was forty-eight, and "Songs in Many Keys" when fifty-five. Washington Irving completed "Tales of the Alhambra" at forty-nine, published "Mahomet" at sixty-seven, and the "Life of George Washington" after that age. Prescott wrote, we believe, the "Conquest of Mexico" between the ages of forty-one and forty-seven, and the "Conquest of Peru" between forty seven and fifty one. Motley completed the "History of the United Netherlands" at fifty-three, and after that began the history of "John of Barneveld," which he published when he was sixty.

Frenchmen have produced very remarkable books long after the noon-day of life. Laplace did an extraordinary amount of mathematical work after three score and ten; and Victor Hugo scarcely "got under way," before he was fifty. He published "Napoleon the Little" at fifty; "Les Chatiments" at fifty-one; "Les Miserables" at fifty-seven; the "Toilers of the Sea" at sixty-four; "The Man who Laughs" at sixty-seven, and the "Annals of a Terrible Year" at seventy. Lafontaine gave the world six books of his "Fables" when forty-seven, five more when fifty-eight, and the last when seventy-three. Lamartine was fifty-seven when he completed his celebrated "History of the Girondins." Beranger wrote, between the ages of fifty-four and seventy-one, ninety-two songs and his admirable "Autobiography." Louis Blanc was fifty-seven when he published his "History of the Revolution of '48." Michelet was over sixty when he wrote "L'Amour" and "La Femme," and did not finish his "History of France" till he was sixty-nine. The great physicist and mathematician, Ampere, did not begin to devote his attention to the phenomena of electro magnetism till he was forty-five, and it was from fifty-one to fifty-three that he published his "Observations," a work characterized, as has been said, "by profound thought and extraordinary philosophical sagacity." Racine was fifty when he wrote his drama of "Esther," and fifty-two, that of "Athalie," the finest production of his genius, and a masterpiece of dramatic eloquence. Thiers was sixty-five when he completed his "Consulate and Empire," and Chateaubriand sixty-three when he published his "Etudes."

Cervantes had passed his fifty-eighth year before he published the first part of "Don Quixote," and was sixty-eight when he issued the second part. He and Shakspeare died on the same day.

Cicero composed most of his philosophical treatises between the ages of fifty-eight and sixty-two. Galileo published his "Dialogue on the Two Principal Systems of the World" at sixty-eight; the "Dialogue on Local Motion" at seventy-four, the age at which he discovered the moon's diurnal libration.

Goethe and Kant, two of the greatest minds that ever lived, did, in view of their later works, scarcely anything till they had passed the age of forty-five. Kant was nothing but a professor till fifty-seven, when he published his "Critique of Pure Reason," on which he had begun work ten years before. When sixty-four he issued his "Critique of Practical Reason," and his "Critique on Judgment" was published two years later. But the most conspicuous literary example of fertility at an advanced age, is Goethe. At forty-eight he published "Hermann and Dorothea," and at fifty-six, his immortal "Faust." "If Goethe," says Carlyle, "had died in 1806 (the year when 'Faust' appeared), he would have achieved a greater renown than any other man of letters; but he was destined to live twenty-six years longer, years of labor and productiveness." In 1809, when fifty-nine, he published "Elective Affinities," and in 1831, at the age of eighty-two, "Helena," the second part of "Faust."

The examples which we have given, and they are only a few of those which history affords, prove, very conclusively we maintain, that the human mind seldom decays and withers before Death casts his shadow upon it.—*Boston Courier.*

MOSQUITOES AS A STIMULANT TO REPRODUCTION.

A GENTLEMAN traveling in the lowlands of this State was surprised to find a great number of children at the different houses which he passed. Stopping at a house where a numerous progeny seemed to abound, he inquired of its maternal guardian for the cause of this universal prolificness. "Oh, my dear sir," she answered, "the mosquitoes are so bad in this country that we folks can't sleep at night!" —*Arkansas Medical Monthly.*

WHAT IS A ZENANA?

By MRS. MURRAY MITCHELL.

I APOLOGIZE to those who know for explaining that the word is a compound of two Persian words, "Zanan-khana," which means simply the house of the women. Now, I think the name is significant—*the house of the women.* This suggests that there is also *the house of the men.* It looks strange, indeed, to us, with our happy united homes, so loved and prized, to think of two separate homes under the same roof, one for the fathers and brothers and sons, and another, and quite separate, for the mothers and daughters and all the female relations. So it is in Bengal.

What above all else constitute the strength and glory of our country? Certainly our Christian homes. But poor India has no home—or, rather, it has a divided home, and no home life. "Home, sweet home!" "No place like home!"—these are words which have no echo in India; they touch no chord in a Hindoo's heart. Ere long, however, this boon will be given to India through the influence of our Zenana work. We shall, with God's help, train the women; and the women make the home.

A lady who paid a short visit to Calcutta told me, only yesterday, that nothing she saw had impressed her so much or so painfully as the miserable surroundings of the women in the zenanas. I don't wonder that she should have felt thus. One glance into their bare, ugly, comfortless rooms would fill any heart with a great pity, and, I think, a longing to help to make them different. There is nothing in the real zenana to make life lovely or attractive; nothing to interest, nothing to amuse, nothing to look at, nothing to do.

The Hindoos live together after a patriarchal fashion. Grandfathers, sons, and sons' sons are all found dwelling under the old family roof-tree. The sons bring home their young wives to their mother's zenana, and hence it is that so many women are often found living in the same house—the mother and all her daughters-in-law, aunts also—and always among them the poor, disconsolate, despised widow.

It is not the case, as some have imagined it to be, that the large number of women residing together arises from polygamy. Polygamy is allowed by Hindoo law, but is seldom practiced, except by the Koolin Brahman.

Every woman has an apartment for herself and her children. These rooms generally open off a veranda facing inward toward a court. One room is a type of all the rest. It has a little matting on the floor, a low cot or bedstead at one end, bare dingy walls, and a small, high, grated window, affording hardly a glimpse of the beautiful, attractive world outside. It may reveal a streak of the pure blue sky overhead, but that is all. The verandas, off which the doors open, look on to a court, or, perhaps, to a garden, with a few sickly, dusty trees, and a little tank of water in the center, in which the women perform their ablutions.

And hard by, divided from the zenana only by a little door somewhere in the wall, are the apartments of the men, which often present a startling contrast to those of the women. You would probably find in them every comfort, every luxury—handsome furniture, soft carpets, pictures, books, means of agreeable occupation, pretty sights within and without. But no woman is ever seen in this paradise, as it would seem to her. She is "*purdah-nusheen*"—living behind the screen or curtain; and, according to Hindoo etiquette or law, it is a disgrace for a high born, high-caste woman to be seen by men with her face uncovered, or to be found outside of her own zenana. When her betrothal takes place—generally at the age of eight or nine, she disappears into her prison home, for the zenana is no better, and comes forth no more, except it be to be carried in a shut-up palki to the Ganges, to wash her sins away in the sacred waters; or to do pooja (idol worship); or perchance to visit another zenana as dreary and dark and miserable as her own. And, observe, the young child-wife does not live any longer with her own mother. From the time of her marriage she belongs absolutely to her mother-in-law; she lives under her roof, and she is subject to her in every sense. If the mother-in-law is kind and good the young creature may be comparatively happy; but if she is despotic or hard hearted, it will be very different. In any case the stringent rules of Hindoo etiquette, with which she has to comply, bind her in what many feel to be intolerable bondage.—*Monthly Record of Free Church of Scotland.*

WHYMPER'S SECOND ASCENT OF CHIMBORAZO.

THE second ascent of Chimborazo was accomplished by Mr. Whymper, accompanied by two Equadorians, as porters, and his two Italian mountaineers, June 26. The flag staff erected by him on the summit, January 4, 1880, was found standing, but buried to the depth of five feet by ice. The flag was in tatters.

During the ascent Mr. Whymper had the good fortune to witness the great eruption of Cotopaxi. He says: "At half past five in the morning the summit of that mountain was perfectly unclouded and there were no symptoms of an approaching outbreak. Ten minutes later a dense black smoke rushed out with great velocity, rising to the height of 2,000 feet above the crater before it began to feel the influence of the wind. It was then carried to the west, and ultimately was struck by a strong northeast wind and was swept along in black fleecy clouds. The effect of the eruption was only too visible when we returned to our tent, which was quite blackened with smoke and coated with ashes. Showers of cinders and ashes continued to fall for several days afterward. It was then that I was overpowered with a feeling of awe far greater than that aroused at the first outbreak from the crater. The effects of the eruption were not confined to the table lands and tracts overlooking the summit of the mountains. When I embarked for Guayaquil on July 10 I found the deck of the vessel covered with

two inches of ashes. Other vessels received the benefits of the showers of ashes at Ambot's Dock in Chala, which lies forty-five miles in a direct line from Cotopaxi.

"A singular phenomenon attending this eruption was the heavy shower of snow which followed it and which was quite black when it reached the earth. As the smoke was swept along by the wind the snow capped mountain seemed no longer to lift its lofty crest to the clouds. A dark pall overspread it as far as the eye could reach."

ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES, AND ON A NEW FORM OF TELEPHONE RECEIVER.*

IN a communication to the Royal Society of Edinburgh, of date January 6, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metal which I have yet tried, in the same direction as the thermo-electric current got by heating the junction of the same two metals. They are also, approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction currents are of some strength and fairly constant, I proceeded to make several kinds of machine for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter, which I have found most serviceable in my experiments, is made by screwing two small cubes of gas carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seemed natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction, or to actual sticking produced by fusion of the points of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point, and the other a smooth surface of metal. This led me to make a modification of the loud speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centers. The rubbing point is made of a sewing needle with its point bent at right angles, and its other end attached to the center of the mica disk of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected.

The variations in the current produced by the transmitting microphone must cause corresponding variations in the heat at the point of contact of the needle with the cylinder, and this again produces a mechanical movement of the pressing point, as well as of the air surrounding it, sufficient to give forth sound waves. If such be the case the effect should be different for different metals, those answering best which have the lowest thermal conductivity and also the lowest specific heat. That this is really so is shown by substituting cylinders of other metals for the bismuth, all other things remaining the same. In this way I have compared lead, tin, iron, copper, carbon, and find that they all give forth the simple loose contact sound when the cylinder is stationary, but that it is only with bismuth that there is any very great intensification of the sound when the cylinder is rotated. Now, by consulting the appropriate tables I find that bismuth is a fraction lower than any other common metal in specific heat, while it is much below them all in thermal conductivity. This seems to bear out my explanation to a certain extent.

IMPROVEMENTS IN THE PRODUCTION OF THE ELECTRIC LIGHT.

By F. H. VARLEY.

THE author describes how he has divided the electric light. In place of carbon points he uses continuous columns of finely powdered graphite or carbon, continually renewed. One method—the powder falls from a platinum or iridium funnel like the sand in a sand-glass, the electricity passing in the direction of the falling particles. The falling stream of carbon is in a closed vessel in a vacuum or a carbonic acid atmosphere. By mixing the carbon dust with borax gravel, etc., the resistance may be varied. In producing the current an arrangement which seems somewhat like a Ruhmkorff's coil is employed. He also describes the use of a battery to work a magneto-electric machine to drive a Holtz machine, and from this the supply of electricity is obtained.—*Zeitschrift A·gewandte Elektricitätslehre.*

* Abstract of a paper rea before the Royal Society of Edinburgh by James Blyth, M.A., F.R.S.E., on May 3 1880.

THE NEW RELATION BETWEEN LIGHT AND ELECTRICITY DISCOVERED BY DR. KERR.

By W. C. RONTGEN.

THE author states that in 1873 he made experiments upon glass and Canada balsam, but found no results such as Dr. Kerr had published on the production of double refraction by static induction. More lately he has repeated Dr. Kerr's experiments, using a lime light and Nicol's prisms of large aperture, and he has confirmed Dr. Kerr's results that the electricity exercises the maximum effects when the lines of force and the plane of polarization of the lights make an angle of 45°, and that there is no effect whatever when they coincide or are at right angles. Various experiments were made with a strained glass compensator, and it was found that carbon bisulphide acted like glass extended along the lines of force, cod-liver oil like glass similarly compressed. With partially conducting liquids effects were obtained when an air spark was interposed in one of the wires, and the electrical machine connected with a Leyden jar; a flash of light was then seen on the field corresponding with each spark, and showing that there is a momentary state of strain in conductors before spark passes. With a high vacuum across which no discharge could be made to pass, no optical defect could be observed, even when a very large electromotive force was employed. The author's experiments agree with those of Dr. Kerr's in showing that different liquids under electric strain act on light like uniaxial crystals, having for their axis the direction of the lines of force, and that, like crystals, they vary from strong to weak and from positive to negative.—*Annalen der Physik und Chemie.*

NEW MEASUREMENT OF THE VELOCITY OF LIGHT.

PROFESSOR SIMON NEWCOMB, superintendent of the *Nautical Almanac*, has finished his new apparatus for measuring the velocity of light. Considerable delay has been experienced owing to the difficulty of obtaining a small cog wheel sufficiently strong and elastic to receive a power giving two or three hundred revolutions a second. Brass, steel, and other metals were tried in vain, and success was only reached when, upon the suggestion of Alvan Clark, of Cambridge, Mass., the renowned maker of telescopes, raw hide was adopted. The wheel is about an inch and a half in diameter, and a little thicker than a silver dollar.

Professor Newcomb has selected for his base of operations a point at Fort Whipple, on the Virginia side of the Potomac opposite Washington, where his apparatus has been set up in buildings erected for the purpose. Recently a correspondent of the *Tribune* had an opportunity to see the apparatus in operation, and of hearing from the lips of Professor Newcomb an explanation of the principles upon which its results are to be worked out.

Its most conspicuous parts are two brass tubes, eight feet in length by about two inches in diameter, placed horizontally at right angles to each other, like the two branches of the letter L, and resting at the angle and at the outer ends upon low solid columns of brick and stone. These tubes are telescopes, differing from ordinary instruments only in respect of their great length and small diameter. One of them is immovably fixed upon its bed of masonry, while the other—being laid in a plane about two inches lower, with its "object" end upon a pivot—swings by means of a delicate screw to the right or left through a radius of one or two degrees.

At the angle formed by the line of the two telescopes, and placed so as to be in the line of vision of both, stands a small mirror of peculiar construction. It is a square column of steel, five inches in length by two in diameter, and plated upon its four sides with nickel. It is mounted, top and bottom, upon pivots, so as to revolve horizontally, and it is to this mirror that the raw hide cog wheel conveys its power. Affixed to one of the wheels which gives motion to the mirror is a device for breaking an electric current, connected with a recording clock, so that the number of revolutions of the mirror each second is automatically recorded. The power to give the mirror its revolutions is furnished by a steam engine built for the purpose and placed in an adjoining building.

A few feet distant from the eye glass of the fixed telescope and in a direct line with the instrument is placed a helioscope—an apparatus consisting of a mirror mounted upon complicated bearings and moved by clockwork, so that when wound up and adjusted it will follow the apparent motion of the sun, reflecting its rays for any desired length of time upon a given point. The rays, or, to speak scientifically, the waves of sunlight, thrown from this instrument are brought to a focus by an intermediate lens upon the eye-glass of the fixed telescope, through which they pass to the surface of the revolving mirror at the other end.

At the Naval Observatory in Washington, some 8,000 feet distant from Fort Whipple across the Potomac (its exact distance will be ascertained by the Coast Survey before actual work is begun), is placed a fixed mirror, circular in form, three feet in diameter, and of such a delicate degree of concavity that light thrown upon it from the revolving mirror at the fort is returned again and brought to a focus as near as may be upon its starting point. In other words, this mirror is a section of the inner surface of a shell which, if complete, would be three miles or more in diameter. Of course, to all appearance, it is perfectly flat.

Now, to understand the working of the apparatus, let it first be supposed that the revolving mirror is at rest. The course of the sun's rays will be as follows: Striking the mirror of the helioscope, they will be reflected through the intermediate lens upon the eye glass of the fixed telescope, through the instrument to one side of the revolving mirror, thence to the concave mirror across the Potomac, by which they are returned to the revolving mirror, and are finally reflected through the movable telescope to the eye of the observer placed at the eye glass. The point at which this telescope rests to receive the sun's rays after they have made their tortuous journey, the revolving mirror being at rest, is marked zero. Now apply the steam and set the revolving mirror in motion. It sounds like the concentrated shriek of a hundred terrified children. Give it 200 revolutions a second, and its four sides will throw 800 reflections of the sun's rays across the Potomac to the mirror at the Observatory. Nothing but the shriek indicates that the mirror is in motion; it looks like a small polished cylinder. The observer no longer catches the sun's reflected rays through the movable telescope at zero, according to the direction in which the mirror is made to revolve, until they again reach his eye. Reflections, following each other with such enormous rapidity, appear as a single reflection.

This, then, is the whole process. It remains only to note the number of revolutions per second, as indicated by the recording clock, and the degree of deflection from its normal position at zero given to the movable telescope, and work out the result as a "sum" in arithmetic. It will be seen that, while a ray of sunlight is making its journey across the Potomac and back, between the revolving mirror and the fixed concave mirror, the former will have made some portion of one of its revolutions. This portion is represented by the degree of deflection which it is necessary to give to the movable telescope to catch the rays upon their return and second reflection from the revolving mirror.

The following propositions, penciled by Professor Newcomb, illustrate more accurately the results to be attained from given hypothesis: Speed of mirror, 200 turns per second; deviation of reflecting ray, $2\frac{1}{2}°$; distance, 1·6 mile. Results: Motion of mirror in 1 second, $360° \times 200 = 72{,}000°$; observed motion of mirror while light is going and coming, $1\frac{1}{4}°$, is $72{,}000 \div 1\frac{1}{4} = 57{,}600$. Then velocity of light $= 2 \times 1{\cdot}6 \times 57{,}600 = 184{,}320$ miles per second.

PHTHISIS.*

By EDWARD G. JANEWAY, M.D., Professor of Pathological Anatomy and Histology, and Diseases of the Nervous System, in Bellevue Hospital Medical College.

OUR patient is a girl nearly seventeen years old, who is a native of Ireland, having come to this country about eight years ago. Her family history would seem to indicate no predisposition to disease of any kind. During the past six years she has been employed in a tobacco manufactory. She was usually employed from seven o'clock in the morning until six o'clock in the evening, though at certain seasons she would have to work until eleven o'clock at night. After getting through her day's work at the factory, she would have to do the family work at home. She had to work because she was poor. I do not know that any of you have ever been in a tobacco factory; I have been in them several times, and the odor from the tobacco on first entering the room was very unpleasant indeed. But the people who work there tell me they soon get used to it, and it is no longer disagreeable to them. Now, besides being confined to this room with its vitiated atmosphere so many hours out of the twenty-four, she was employed over the boiler, and there were seventy-five persons in the room. There is always more or less dust in such a place; she works until eleven o'clock at night, which is more than any man ought to do, let alone a young growing girl, and she keeps that up for six years. At the end of that time, perhaps after a little exposure, she begins to have a cough and has to come to the hospital. She says she has lost no flesh, but that is doubtful; she has no night sweats, she spits no blood; but she has a cough, and she is pale. We will see whether she has much trouble with her chest. But you could not put a person in better conditions to develop disease in the chest than those she has been in. But she says she is poor, and had to earn a livelihood, and for this reason she went at this work at so early a period of life, continuing at it steadily for six years, working both early and late.

As I percuss over the apex of the right lung you will notice that the sound is duller than it should be; the same is true in a lesser degree over the left lung. I hear numerous moist rales over the upper part of both lungs anteriorly, and I hear them behind in the supra scapular fossa, and with that the respiratory murmur is feeble. You can hardly get the type of the respiratory murmur, because the rales take the place of it. These rales are produced by bubbles breaking in the bronchial tubes. But there is something about these sounds which does not belong to ordinary mucous rales, and it would lead you to suspect the presence of consolidation at different points, more advanced on the right than on the left side. It is true that these sonorous rales indicate the existence of a bronchitis, but there is more than that here; there is phthisical consolidation. She has consumption of the upper lobe of both lungs, and that consumption is progressing pretty rapidly. There are patches of sound lung tissue in between the diseased; or we have in other words consolidation in patches. An examination of her lungs would show us that she has cheesy or tuberculous pneumonia, and that the patches of consolidated lung are beginning to break down and excavate.

Now, what is the prognosis in such a case? The prognosis is bad. This girl has for years violated all the laws of health at a time when she should have been a certain length of time every day out in the open air, where she could run and play, grow and develop. Instead of that, she has been confined at work, and has had to work harder than anybody should, and in an atmosphere which nobody should breathe, and as a result she has got a disease which we can do nothing for except perhaps to slow its progress; but within a little while, perhaps within a year, we shall see the end of her life. We cannot say positively, but pretty certainly, that the disease will make rapid progress, more so than in the past. There is one thing in her favor to a certain extent, though not very much, and that is she has no hereditary tendency to phthisis. But the disease can be brought on in people who have no hereditary predisposition to it, and that is one reason why I have brought this patient before you to-day. Now, here is a girl nearly seventeen years of age, with no hereditary tendency to phthisis, who by a violation of the laws of health has brought about a disease which will shortly prove fatal. If before four months ago, at the time when the apex of her right lung first began to be affected, she had changed her mode of life, and taken more out-of-door exercise, or if she had gone to common housework in the country, instead of continuing at work in a tobacco factory, she might to-day be a perfectly healthy person. And right here let me say that it is a great deal wiser to prevent consumption than to wait until it is developed and then try to cure it. These are the points I wish to make in connection with this case, namely, that phthisis may be developed in a person in whom there is no hereditary tendency to the disease; that tobacco factories, and many other factories, are the places where phthisis often originates; and that it is much better to take such steps as shall prevent the development of the disease than to wait until after its development and then try to effect a cure. I do not intend to enter particularly upon the symptoms of phthisis, as this subject will be fully explained by one of my colleagues before the close of the session.

Now the question of course will arise in these cases, what shall you do with them? And if the patient be a person of means you will be questioned with regard to sending him away. Now it might be advisable for this girl to go away to a climate where she could be more comfortable. During the winter season, when she could not go about in the open air here, she might go south. Now physicians in the South, in Colorado and California, think almost always when phthisical patients are sent to them from the East and North,

* From a Clinic at Bellevue Hospital.—*Medical Gazette.*

that they are sent there to get well. And herein they make a mistake, for the majority of patients who are sent to those places are not sent with the expectation of their getting well, but that they may be in a climate where they can be more comfortable than at home. I have sent some patients to other States *not* to be *cured*, but that they might *live more comfortably* while they did live, and that they might have a chance of living three or five years longer than they would if they remained at home.

CALLENDER'S METHOD OF TREATING ABSCESS.

THIS little boy was brought here nearly two years ago, with spinal disease, but the feature of special interest in regard to it was the existence of an enormous abscess in the lumbar region; an abscess containing about a pint of pus. You will remember that within the last two or three years we had a visit to this country by Mr. Callender, an eminent surgeon of —— Hospital of London. He made a subsequent visit to this country and died of Bright's disease on the voyage home. When Mr. Callender was here he gave a lecture in Bellevue Hospital on the treatment of abscess by the method known under his name, described by himself as hyperdistention; that is, opening the abscess by a moderate-sized opening, and then injecting a solution of carbolic acid, about one to thirty or forty, in such quantity as to distend the walls of the abscess to an extreme degree in order to make the antiseptic fluid penetrate the utmost recesses of the abscess. He represented that after such an injection of a chronic abscess the walls of the abscess will contract, and none of the usual symptoms of septicæmia will occur; that the abscess will contract to a mere sinus, and then, if there be no permanent cause to keep it open, it will heal up entirely. I have had occasion to carry out Mr. Callender's method in a number of cases at this clinic and in the Presbyterian Hospital, as well as in private practice, and with very marked benefit. This is one of the most remarkable cases in which it was applied. This enormous abscess, containing about a pint of matter, was in a boy about five years old. The contents of the abscess were discharged, the cavity injected with a carbolic acid solution, and there was very little suppuration after the contents of the abscess were first discharged. The injection was repeated in small quantities several times afterwards, but the walls of the abscess contracted so that the discharge did not amount to more than a teaspoonful or two in the course of twenty-four hours, and after a time the abscess healed entirely. Now, under the old treatment, where these abscesses were allowed to open spontaneously, or were opened by art and left alone, the general result was, that symptoms of septic poisoning developed and the cases very frequently proved fatal; or if the patient recovered, it was only after having a very high degree of septic fever, the recovery being doubtful for a long time. The abscess healed entirely. But as there was still spinal disease I sent the patient to Dr. Sayre, who applied for this his apparatus.

Where the spinal disease exists pretty high up in the dorsal region you do not get a sufficient hold with the plaster jacket alone to keep the fragment in proper apposition, and Prof. Sayre is in the habit of superadding to the plaster jacket this steel bow, which is connected with a sort of helmet applied around the head, and which is called by Prof. Sayre the jury mast. It takes the weight of the head off of the diseased vertebræ. If the disease of the spine is low down in the dorsal region, or in the lumbar region, the plaster jacket without the jury mast is all that is required.

I show the case especially because I believe the patient's life has been saved by Mr. Callender's method. Had the abscess been allowed to open spontaneously, which it would have done after a time, or if it had been opened by art and not injected by the carbolic acid solution, I believe the patient would have died from septic poisoning. It is a very excellent case to illustrate the benefits of Mr. Callender's method.—*From a Surgical Clinic by Dr. Alfred C. Post, New York.*

PARASITES IN MUSCLE IN TYPHOID FEVER.

Two cases of parasites existing in the voluntary muscles of patients with typhoid fever have been reported to the Pathological Society of London. The first case was that of a young man in St. Thomas's Hospital, who died of peritonitis set up by perforation of a characteristic enteric ulcer. In the pectoral muscle were found what were taken to be parasitic worms, one or more of which were seen in each specimen; apparently, from their movements, they were still alive. Their dimensions were wholly different from those of trichina spiralis, being about a quarter of it in length and breadth. They were thickest in the middle, with one end larger than the other. They resembled nematoid worms both in the proportion of their breadth and length, and in the presence of an interior canal, apparently interrupted by some intervening organ or tissue. The other case occurred in the Seaman's Hospital, and on examination of the muscles the same bodies were found. In neither case, however, were the parasites so plentiful as was at first supposed. They were found in all muscles equally, except in the diaphragm, but they were not uniformly disseminated through a given muscle.—*London Lancet.*

ACUTE RHEUMATISM TREATED BY HOT WASHING-SODA BATHS.

IN the *Australian Medical Journal*, for April, two cases of acute rheumatism treated by hot washing-soda baths are reported by Mr. Bingham Crowther, L.R.C.P., as occurring under the care of Dr. E. L. Crowther. In this treatment the patients are taken in a blanket by the four corners, and lowered down in a recumbent position into the bath. Half a pound of common washing-soda is added to the water, as hot as can be comfortably borne, the patient remaining in from ten to fifteen minutes, then lifted into a dry, warm blanket, and replaced in bed. According to the reporter, profuse diaphoretic action follows, along with diuresis, to the immediate relief of the sufferer, pains rapidly depart, and sleep follows the use of the remedy. In one severe case convalescence was effected in eleven days. The other case was treated without permanent benefit with salicylate of soda and various sedatives and salines. On the 25th of December, 1879, "the patient becoming immovably fixed in bed by the affection of new joints, and all remedies proving useless, the washing-soda bath was tried as a last chance. After remaining in ten minutes he was removed. His complexion soon changed from a muddy to a natural color, and the pains left the joints." On the 27th there remained only a little aching in the body and slight pain in the left wrist. Complete recovery having been established on the 8th of January, the baths were discontinued.

THE STRUCTURE OF SPERMATOZOA.

IN the current number of the *Quarterly Journal of Microscopical Science* is a short paper by Dr. Heneage Gibbes, in which he states that he has found the spiral filament, discovered by him in the spermatozoa of several species of animals, as the rat, mouse, axolotl, pigeon, fowl, snail, and leech. In the examination of different specimens of human spermatozoa, he has noticed a variation in the length of the tails, and in one specimen he found a number of heads with no corresponding tails. He throws out the suggestion that these variations may have some important bearing. It is quite possible that tailless spermatozoa may not be able to fertilize the ovum, while the greater the length of the tail the greater their locomotion and fertilizing power may be. Dr. O. S. Jensen, of Bergen, has found the spiral filament in the semen of horses; and Professor Fleming, of Kiel, has also confirmed Dr. Gibbes's observations, both as to the existence of this filament, with its mesentery, and the different reaction to staining fluids of the head and middle part of spermatozoa.

TUBERCULOSIS AS AN INFECTIOUS DISEASE.

DR. L. G. BRYHN relates, in *Norsk Magazin for Lægevidenskaben*, some cases in proof of the infectious character of pulmonary tuberculosis, of which he has become convinced by observations made during a practice of thirty years' duration. A phthisical man married a woman of healthy family; the man died, the woman became phthisical, as did also her sister, who resided in the house during the man's illness. The latter married a man of great strength, of sound family; he, too, was attacked, and also his sister's daughter, who resided some time in the house. One of their children died of tubercular meningitis, two had signs of pulmonary tubercle, one was free. The girl who served the first man's wife became tuberculous, went home, and died. Her sister was infected by her; both their parents had lived to a great age, and tuberculosis had never before shown itself in the family.

RAPID BREATHING AS A PAIN OBTUNDER.

IN 1875, Dr. W. G. A. Bonwill, a dentist of Philadelphia, discovered that, by causing his patients to breathe rapidly for a few minutes, the sense of pain was often so obtunded that he could extract teeth without causing any discomfort. The matter was, soon after this, taken up by Dr. Addinell Hewson, who made a favorable report of his experience with the method at the International Medical Congress, in 1876. Not much interest was excited however, and the subject was virtually dropped.

At a recent meeting of the Philadelphia County Medical Society, papers upon rapid breathing as a means of inducing analgesia, were read by Dr. Benjamin Lee and by Dr. Bonwill. Considerable discussion followed. A perusal of the papers and discussions leads to the conclusion that there may be something of considerable practical value in Dr. Bonwill's discovery. At any rate, as it is a thing which can be easily tried without risk to any one, we give briefly the facts regarding it.

In some cases it is necessary, when rapid breathing is to be undertaken, to have the patient sitting in a chair. The most favorable position for him, however, is that of lying down on the side; and it is generally best to throw a handkerchief over the face, so as to prevent the patient's attention from being distracted. He should then be made to breathe at the rate of about one hundred respirations per minute.

The direction best given is to "blow out" in rapid puffing expirations. At the end of from two to five minutes, the patient continuing his rapid breathing all the time, teeth may be drawn or incisions made, and there will generally be an entire or partial absence of pain which will last thirty seconds or more. The sense of touch is not affected, nor is consciousness gone. When the breathing is first begun the patient may feel some exhilaration; following this comes a sensation of fullness in the head or dizziness. The face during this time becomes at first flushed, but later, according to Dr. Hewson, it is pale or even bluish. The heart beats more feebly and somewhat faster than normal.

We are told that this phenomenon of analgesia is produced in females more readily than in males, and in those of middle age more easily than in the young or old. Children under ten can rarely be made to breathe properly. In cold, clear air a longer time is required than when it is warm.

Regarding the practical uses of the method, it is claimed that it may supplant ether, chloroform, or nitrous oxide in dentistry, minor surgery, and often in obstetrics. In the latter case it is especially applicable when the forceps are to be used. A case of tracheotomy and one of ischio-rectal abscess were related in which analgesia was successfully produced by rapid breathing. The ordinary anæsthetics, when employed for major operations, can be made more effective by combining with them rapid breathing. According to Drs. Garretson, Hewson, and Ki'e, it takes from one-half to three-fourths less of the liquid anæsthetics to produce insensibility when the administration is supplemented by rapid breathing. The after-effects are also less nauseating and unpleasant.

As regards the possible dangers, it is denied that there can be any. Dr. W. R. D. Blackwood, however, stated that he had tried the method on a somewhat hysterical patient, who kept on breathing rapidly for so long a time that he was somewhat alarmed.

The theories of how the rapid breathing acts in thus obtunding pain are as yet unsatisfactory. Dr. Bonwill and Dr. Hewson, its two especial champions, entirely disagree in their attempts at explanation. Dr. Bonwill assigns three causes: 1st, the diversion of the will force caused by the rapid voluntary muscular action; 2d, the specific effect of carbonic acid gas set free from the tissues, caused by the throwing into the lungs five times the normal amount of oxygen; 3d, hyperæmia, due to the excessive amount of air passing into the lungs and causing a damming up of the blood in the brain. The main point of the theory is that rapid breathing produces a hyperoxidation of the blood, which sets carbonic acid free in the tissues. Dr. Hewson, on the other hand, believes that there is a diminished oxygenation of the blood during rapid breathing, and that the excess of carbonic acid which results poisons the nerve-centers and causes analgesia.

It is unnecessary to discuss these theories. The one is crude, and neither is sufficient. As far as the method itself is concerned, it seems to be well proved that analgesia to a greater or less extent can be obtained by it. Its practical usefulness is not so well established. A good many failures have occurred, and a large amount of evidence is yet to be obtained in order to show its reliability. The method is simple, however, and there ought not to be any trouble in speedily determining its exact value.—*Medical Record.*

THE MANUFACTURE OF CINCHONA PRODUCTS.

THE *Bulletin* of the National Board of Health gives in a recent issue the following report on the manufacture of quinine and other alkaloids from cinchona bark in Italy, by D. J. Crain, U. S. Consul at Milan:

The manufacture of the salts and sulphate of quinine is an important Italian industry. It has been carried on at Milan and Genoa since 1870. Twenty-two thousand five hundred pounds are consumed yearly in Italy, of which one-half is made at Milan, 6,750 pounds at Genoa, and the balance imported from Germany. Forty-five thousand pounds of quinine and salts of quinine are produced in Italy. The production of the world is estimated at from 230,000 to 260,000 pounds per year, as follows: Germany, 56,250 pounds; Italy 45,000 pounds; France, 40,500 pounds; England, 27,000 pounds; America 63,000 pounds; India, 12,250 pounds.

The two Italian factories produce 45,000 pounds of the sulphate of quinine, viz., 40,500 pounds at Milan, and 4,500 pounds at Genoa. The first of these employs 45 hands, the second 15.

The Milan factory ships largely to all parts, furnishing much to Russia, France, and Austria. England receives two-thirds of her supply and Holland one-half of hers from the same source.

Efforts will be made to acclimatize the cinchona in Italy, to increase the supply and lessen the cost of the product. Its successful culture in India and Ceylon encourages the belief that it will grow wherever the soil is dry, the rain-fall large, and climate temperate. Many parts of the United States meet these conditions, and notably where its product is needed.

The culture of the cinchona in our country would cheapen an indispensable medicine and open a new industry to capital and labor.

In this connection some facts reported by Mr. E. Van Estvelde, the Consul-General of Belgium in Italy, are instructive. He reports that the best varieties of cinchona have been successfully acclimated in British India. The government there cultivates chiefly the *Cinchona succirubra*, which has a red bark and contains a large quantity of febrifuginous alkaloids, and the *Cinchona calisaya*, which has a yellow bark, and is better suited to the manufacture of quinine. The culture of the first has succeeded. Uncertainty still exists as to the *Cinchona calisaya*, and the Bengal government are examining the plantations of Java, where it has been cultivated with entire success.

The cinchona plantations are in two distinct regions of India, *i. e.*, north of the Nilgiri Hills, in the Madras Presidency, and on the slopes of the Himalayas.

Those of the government are as yet the most important, covering 1,300 acres on the Nilgiri Hills and nearly 3,000 acres in Sikkim. There are several private plantations of later date already producing marketable bark.

The red bark (*Cinchona succirubra*) has many febrifuge alkaloids, but little quinine. It was important, therefore, to determine the therapeutic value of these alkaloids and the cheapest means of extraction in order to furnish a good febrifuge at a moderate price. The medical commission recommended the extraction of cinchonine, cinchonidine, and of quinine by simple means, and the government now sells a mixture of these three alkaloids under the name of "cinchona febrifuge."

As the price does not exceed 65 cents per ounce, this febrifuge is used in nearly all the hospitals of India and sold in large quantities to the public. The chief surgeon of the northeast provinces reports that the doctors are unanimous in declaring that the "cinchona febrifuge" is a medicine of recognized efficiency in the treatment of ordinary intermittent fevers, and that it is an excellent prophylactic for those who live or travel in marshy countries. Most doctors are, however, of the opinion that it is inferior to quinine as a therapeutic agent; that its effect is slower, and that it is insufficient to cure severe remittent fevers. That it is a medicine of value is shown by the increase of its use, which, as the following figures show, is remarkable: 1874–75, 48 pounds; 1875–76, 1,940 pounds; 1876–77, 3,750 pounds; 1877–78, 5,162 pounds; 1878–79, 7,007 pounds.

The hospitals took more than 5,500 pounds in 1878–79; and, as the use of quinine diminished in the same time about as much, it is proof, considering the cost of the last named alkaloid, that the Indian government saved about $125,000.

At the present time the government chemist of India is trying to produce a better febrifuge by mixing three sulphates, viz., cinchonine, cinchonidine, and quinine, of which the cost would be little higher.

Financially the plantations of Sikkim gave last year a net profit of $19,252.80, although not fully developed, or 4½ per cent. on the sum invested. By the prevention of disease the hospital expenses of the government were largely lessened.

The value of these facts in their relation to the United States is apparent.

ON THE REDUCTION OF CHLORIDE OF GOLD BY HYDROGEN IN THE PRESENCE OF PLATINUM.

By DR. D. TOMMASI.

WHEN a solution of chloride of gold is acted on by hydrogen in the presence of platinum the chloride of gold is reduced to the metallic state. To what is this reduction due? Let us examine the facts: An aqueous solution of chloride of gold has no action on a strip of platinum, neither has the hydrogen any action on the chloride of gold; but the platinum put in the presence of hydrogen has the property of absorbing a certain quantity of this gas.

The starting point of the reduction of the chloride of gold is in the condensation of the hydrogen on the platinum. The platinum in absorbing the hydrogen disengages heat, and it is precisely this heat which determines the reaction between the hydrogen and the chloride of gold. This reaction once commenced can continue of its own accord, and give place like all chemical reactions, to an electric current.

The electric current observed by Dr. Phipson is not therefore, the initial, but the final action; the disengagement of electricity does not start the reaction between the chloride of gold and the hydrogen, but it is, on the contrary, this chemical reaction which starts the electric current. What is, in Dr. Phipson's opinion, the cause of this reaction is, according to my idea, the effect of it.

By substituting for the strip of platinum another metal which has no action on the chloride of gold, and which does not absorb hydrogen, I am convinced that no reduction will take place; and I believe that if, instead of platinum, palladium were used, the reduction of the gold would take place with much greater energy, because palladium can absorb much more hydrogen than platinum absorbs.

DETECTION AND DETERMINATION OF OILS.

By M. A. RÉMONT.

THE qualitative analysis ought to be preceded by an examination of the organo-leptic properties of the oil, the manner in which it behaves under the influence of heat, and of its specific gravity, which often gives useful indications. Thus, if the specific gravity of the sample is below 0·900 it certainly contains a mineral oil; if from 0·900 to 0·975, we may be in presence of the most complex mixtures; but if it is above 0·975 we have certainly an oil of resin.

We begin by treating the sample with carbon disulphide, freshly prepared, which gives a clear solution with all the oils. If oleic acid or a fatty oil has been mixed with alkali to raise its specific gravity by the formation of a portion of soap, there will appear a precipitate. In this case the liquid is filtered, and the residue is washed with carbon disulphide. It may be proved to be soap by its solubility in water, its alkalinity, and the turbidity, more or less marked, which is caused by an acid poured into the solution.

The filtrate is freed from the carbon disulphide by distillation: 1 c.c. of the residue is taken and mixed with 4 c.c. of alcohol at 85°. If solution takes place fatty acids are present, pure or mixed, and an excess of alcohol is gradually added. If after having poured in 50 c.c. the liquid is limpid, or there is produced a very slight cloud, which disappears on adding a drop of hydrochloric acid, the sample consists of oleic acid, pure or mixed with resin. If the specific gravity does not exceed 0·905 at 15° the sample consists entirely of oleic acid. If the specific gravity is higher the oleic acid contains resin. By way of confirmation the substance is examined with the polarimeter, either directly or dissolved in carbon disulphide, and if there is a deviation we may be certain of the presence of a resinous mixture.

If we find a persistent cloudiness in the alcoholic solution it is because the fatty acids contain an oil sparingly soluble in this solvent, and in so much the greater quantity as the cloud appears earlier. This very sensitive process renders it possible to detect 2 or 3 per cent. of heavy mineral oil, or of resin, or fatty oil in the oleic acid known in commerce as oleine. The turbidity produced in the alcoholic liquid resolves itself in some time into little oily drops, which line the sides of the vessel, and which can be made by a shock to fall to the bottom of the tube. The volume of this residue shows approximately the proportion of insoluble matter.

The most common case is when 4 parts of alcohol do not completely dissolve 1 part of oil. A larger quantity of the latter is then taken, and agitated with an equal volume of alcohol. After settling for a time, the alcoholic solution is decanted and evaporated in a capsule. The nature and the quantity of the residue serve as a clew to the nature of the mixture.

I submit the oil to the action of caustic soda, employing the method indicated by M. Dalican for the analysis of tallows. In a capsule of porcelain, or, preferably, of enameled cast iron, there are weighed about 20 grammes of oil, and heated to 100° to 110°. There is then poured in a mixture of 15 c.c. soda lye at 36° B., and 10 c.c. of alcohol; the mixture is stirred and heated until the alcohol and the chief part of the water have disappeared. Then 150 c.c. of distilled water are added, and the boiling is kept up for half an hour, when three cases may occur:

1. The oil, under the influence of the alkali, is merely emulsified, and on the addition of water it separates distinctly; this indicates either a mineral oil, a resin oil,* or a mixture of the two. The aqueous solution is decanted off, and it is mixed with sulphuric acid. If there is no precipitation, or if a mere slight cloudiness is produced, the sample is a pure mineral oil. If there is a considerable precipitate which collects in brown viscid drops, giving off a strong odor of resin, and soluble in an excess of alcohol, we have a resin oil, pure or mixed. The oil is examined with the polarimeter, and if it acts upon polarized light this is a confirmation of the presence of resin oil. If the specific gravity is below 0·960 there is probably a mixture of mineral oil. Good indications may also be got by distilling if one of the oils is not in too trifling proportion. The distillation ought to be fractionated as far as possible, and conducted slowly. As the resin oils boil, as a rule, at lower points than the mineral oils, it follows that in place of having specific gravities which increase with the boiling points, as happens with the heavy mineral oils or pure resin oils, there are observed, with their mixtures, very abrupt transitions. The sample ought to be tested with tannic chloride, and if the violet coloration is not very distinct, the same reagent should be applied to the first products of distillation, since the colorable product contained in the resin oils is there chiefly met with.

2. Or there is formed by the action of caustic soda a paste-like mass of soap, which on treatment with water and boiling for some time gives a clear liquid. It is diluted with cold water and then supersaturated with an acid. The fatty acids liberated collect on the surface after decantation of the water, and if exposed to cold they crystallize. A small portion is melted in a tube at a gentle temperature, and 4 parts of alcohol at 85° are added first and afterward an excess. Here two cases are possible:

A. If no precipitation takes place it is because the fatty acids are pure, which shows that the oil examined is a pure fatty oil, or, which rarely happens, mixed with resin. The specific gravity of the fatty acids may here give good indications, but it cannot be taken at common temperatures, at which fatty acids are solid. They must be melted, and the specific gravity taken at a known temperature. M. Baudouin, chemist at the Arnavon Soap Works, at Marseille, has drawn up a table of the specific gravities of the fatty acids of certain oils taken at 30°. Except those of linseed oil, which marks 0·910, those of the other fatty oils have specific gravities ranging from 0·892 to 0·900. To reduce the specific gravities of the fatty oils examined to the temperature of 30°, deduct from the density found, calculated on a liter, as many times 0·64 gramme as there are degrees below, or if the temperature is higher to add to the density found as many times 0·64 gramme as there are degrees above. If the specific gravity indicates that the neutral oil contains resin an attempt may be made to separate it, in part at least, rapidly by agitating 5 or 6 c.c. of the original oil with an equal volume of alcohol, decanting after settling, and evaporating in a capsule. There is thus obtained a solid or semi-fluid residue in case of resin. Further examination is then made with the polarimeter.

B. The fatty acids derived from the decomposition of the soap give a precipitate if treated with an excess of alcohol. If it is not redissolved by 1 gramme of hydrochloric acid, and if after some time it is resolved into oily drops, it is due to a mineral oil or a resin oil. A fatty oil containing 10 to 15 per cent. of one of these oils is completely saponified, and yields with boiling water not an emulsion, but a soap completely soluble. The turbidity should resolve itself into oily drops, for there are certain fatty acids—those, among others, of the oil of earth nuts (*arachis*)—which are soluble in a small proportion of alcohol at 85°, but an excess of the alcohol precipitates a sparingly soluble portion, arachidic acid, in small flocks. These flocks may be collected on a filter, and examined as to their complete solubility in alkalies. If their melting point is near 73° they may be attributed to the oil of earth nuts.

3. Or, lastly, the oil, on treatment with soda, may give a paste more or less firm, which, if placed in boiling water for half an hour, allows oily drops to rise to the surface, which are due to a mineral oil or a resin oil. After settling for some minutes a part of the supernatant liquid is decanted and mixed with an excess of a saturated solution of common salt. There is produced a precipitate of soap, which is filtered off on cooling. The filtrate is supersaturated with an acid. If there is produced a slight turbidity, and if the liquid, which was almost colorless when alkaline, gives off an odor of fatty matters, we have a neutral oil mixed with a non-saponifiable oil. If, on the contrary, the solution was highly colored after filtration, and gives when acidified a flocculent precipitate of a resinous odor, the sample is a mixture containing resin. In these two cases, the components of the mixture may be recognized by means of the procedures indicated above.

Quantitative Analysis.—If it is desired to know the elements attacked by alkalies, and of those which are not, the following procedure is to be followed: If the sample has yielded anything insoluble in carbon disulphide, it is separated as already said, and the operation is confined to the residue of the distillation. Let it be assumed that the composition of the residue is as complex as possible, containing fatty oils, mineral oils, resin oils, and solid resin.

The mixture is saponified. Into a flask closed by stopper, through which passes a long tube, are introduced 20 grammes of the oil, and a mixture of 15 c.c. of soda at 36° B., and 15 c.c. alcohol at 90 to 95 per cent. The flask is then set upon the water bath for half an hour and is often shaken. At the end of this time the whole is poured into a tunnel fitted with a tap and previously warmed, and which is left in a stove at 50° to 60° until a complete separation of the non-saponifiable oil from the alkaline liquid has taken place. The latter is then decanted into a porcelain capsule, and in its stead is poured 15 c.c. of boiling water which has served to rinse the flask. It is shaken well so as to wash the non-saponifiable matter, and decanted anew after settling. Finally, it is washed a third time with boiling water. The oil in the funnel is received into a tared capsule and weighed. As for what adheres to the sides, it is washed with a little ether, and the solution is received in another capsule; which is exposed to the air till the bulk of the ether has disappeared. It is then gently heated to expel the rest and weighed.

The alkaline liquid is kept at a boil for some time to expel the alcohol, and after cooling it is mixed with an equal volume of a saturated solution of common salt, freed from magnesia by being boiled for a few moments with caustic soda and filtered. In this manner the soap is precipitated in firm clots, carrying with it the last portion of non-saponifiable matter. The saline solution, after settling, is decanted by means of a pipette, and neutralized with an acid. If a notable turbidity is produced, which collects in flocks, it is due to resin. The flocks are collected, dried, and weighed. The clots of soap are thrown upon a filter, washed twice with salt water, the last traces of which are removed by pressing the mass between blotting paper. The soap is then placed in a glass cylinder, moistened with about 100 c.c. of carbon disulphide recently rectified, stoppered, gently shaken at intervals three or four times, so as not to break the clots, and left to settle. After an hour or two the carbon sulphide, which is colored yellow by the dissolved oil, separates in the lower part of the cylinder. It is decanted by means of a pipette, and in its stead is added a fresh portion of the solvent. It is shaken, left to settle, decanted, and so on till the carbon sulphide runs off almost colorless. The whole is then thrown upon a filter and washed for the last time. A portion of this last washing, if evaporated upon a watch-glass, should leave an insignificant residue.

The soap on the filter is exposed to the air till the carbon disulphide with which it is saturated has escaped.

As for the carbon disulphide solution, it is distilled gently on the water bath. The last portions of the solvent are expelled by blowing air into the flask while placed in boiling water. When cold it is weighed.

The last portion of the non-saponifiable matter thus obtained ought to have the same appearance as the first portion. If it is less fluid it still contains a portion of soap. In this case it is again taken up in carbon disulphide at a gentle heat in presence of a few drops of water to hydrate the soap, which, without this addition, would again be partially dissolved. It is then filtered and the washed soap is added to the chief mass.

The non-saponifiable oil may consist of mineral oil, resin oil, or a mixture of both. The means of detection have been given above, and I have not yet come upon a process for their separation.

The soap insoluble in carbon sulphide which lies on the filter contains resin and fatty acids combined with soda.

The separation of these substances, so similar in their properties, presents many difficulties. Several methods have been published, but none of them gives satisfactory results. That of M. Jean, one of the most recent, consists in exhausting the barium soap with ether, which ought to dissolve the resinate and leave the soaps of the fatty acids untouched. On following exactly the author's instructions, I have never been able to avoid the partial solution of the barium oleate. I have modified the process by substituting for the ether boiling alcohol of 85 per cent., which certainly dissolves much less of the oleate, but still takes up enough to render the results inaccurate.

As far as possible the soap is separated from the filter and placed in a capsule. The filter is put back in the funnel and filled with boiling water. The solution is effected slowly and filters by degrees; it is received in the capsule where the detached portion has been already placed.

The solution of soap, after cooling, is mixed with caustic soda until precipitation no longer ensues, and left to settle. All the soap of the fatty acids is deposited, drawing down with it the chief portion of the resinate, a part of which, however, remains in solution and colors the liquid strongly. The whole is filtered, the filtrate accurately neutralized with sulphuric acid; the flocks of resin deposited are received upon a tared filter which is weighed anew after washing in water and drying at a low temperature. The soap is redissolved in a little lukewarm water and an excess of barium chloride is poured into the solution with agitation. The clots of barytic soap are drained in a filter pump, replaced in the capsule in which the precipitation has been effected, and thoroughly dried in the water bath or the stove. The mass is then powdered, and treated with 50 or 60 c.c. of alcohol at 85 per cent., which is kept near the boiling point, working it up with a pestle. It is left to settle for a few moments and the supernatant alcoholic liquid is then decanted into a vial. 20 to 25 c.c. of alcohol are again poured upon the residue, let boil, decanted after settling, and so on till a portion of the alkali which has been used leaves, on evaporation, scarcely any residue, which happens generally after 120 c.c. of alcohol have been used.

The alcoholic liquids are mixed and distilled till there remains only about 50 c.c. Hydrochloric acid is added to decompose the resinate, and the resin set at liberty floats in the liquids. On cooling it collects in a solid mass at the bottom of the vessel. It is thrown into a capsule, melted under water, and weighed after desiccation on the water-bath.

The residue insoluble in alcohol is treated in a similar manner to obtain the fatty acids.—*Bulletin de la Société Chimique de Paris.—Chemical News.*

PROCESSES FOR PURIFYING OILS WITH ALKALIES.

By M. BLONDEAU.

1.—PROCESS APPLICABLE TO COLZA AND RAPE OILS.

THIS method, which has been in use for some time, is due to M. Evrard, of Douai.

The oils, which should be drawn cold or at a very slight heat, are well crutched up with a weak lye of soda or potash, and the whole is then allowed to settle. There are soon formed two layers in the liquid; below there is the alkaline liquid which has a milky appearance, while above floats a neutral oil, and where the two come in contact there is an emulsion which partakes of the properties of both. The alkaline milky solution is drawn off, and in its place is put water, rendered also slightly alkaline, and the whole is left to settle. This process is then repeated a few times with pure water till the liquid which collects at the bottom of the settlers has only a very slight milky appearance. The oil is then drawn off, and the small quantity of emulsion which remains between the oil and the water is again allowed to settle apart, either in the cold or in the water bath, according to the kind of the oil and the temperature of the air. The oil is finally filtered.

Colza oil thus prepared is, according to the author, perfectly fit for use in lamps; it burns with a steadier flame than that purified with sulphuric acid, and it also attacks the copper and brass work of lamps less.

The milky and alkaline waters derived from the process are treated with a little acid, and the fatty matter present—in reality fatty acid—rises to the surface, and is easily collected; it is fit for the manufacture of soap.

2.—PROCESS SUITABLE FOR COTTON-SEED OIL, ETC.

If the cotton-seed is old the oil will be brown. To purify it we prepare a lye of soda at 63° Tw. Then to 20 parts of this caustic lye we add 2 parts of lime in powder to increase its causticity. [If there is no undecomposed carbonate of soda in the lye the addition of lime can have no effect in increasing its causticity.] For 100 parts of the oil we take 5 parts of this lye, and work it well together, raising the heat to 136° F. On ceasing to heat the coloring matter separates out along with the alkali, and the colorless part is decanted and filtered.

The effect of the alkali is increased by adding to the mixture of twenty parts lye and two parts of lime ten parts of bone black in powder.

The oil thus purified is not more colored than olive oil, and may be used in lamps, for the manufacture of white soaps, for oiling wool, for painting (?), and even in food, as it has little rancidity. [There must be some mistake here: for painting, a drying oil is required, but drying oils are very unsuitable for lamps and for wool spinning.]

The deposit or sediment is decomposed with milk of lime in the proportion of 15 parts of actual lime to 100 parts of fatty matter. It is boiled until the mass becomes in part pasty, and the alkaline and caustic water is then drawn off and concentrated to the degree necessary for purifying a fresh lot of oil.

When the lye contains such a proportion of glycerine as to interfere with its action, it is evaporated to dryness and calcined, so as to yield a carbonate of soda, which is again rendered caustic by known means.

As for the calcareous soap it is mixed with water at 212° F., and boiled till there is a complete combination of its component elements; and lastly, it is distilled in slender layers, which are constantly renewed, in a current of steam, so as to obtain oleine and margarine by known means. Or the lime soap may be decomposed by an acid.—*Moniteur des Produits Chimiques.—Chemical Review.*

IMPROVEMENTS IN THE PRODUCTION OF AMMONIA.

A NITRATE, or a nitrite—by preference nitrate of baryta or of potash—is heated in a retort, and the gases, products of decomposition, are brought in contact with the vapor of water in another heated retort filled with coke. Here the nitrogen and the hydrogen set at liberty combine and form ammonia.

This process may be worked with a single retort if the nitrate which is to be decomposed is mixed with hydrate of potash and carbon. In this case an alkaline bicarbonate remains in the retort.

The base which remains in the first retort may be restored to the state of a nitrate or nitrite. For this purpose it is brought in contact with nitrogen and oxygen under the influence of electricity. The operation takes place in an earthen vessel containing, for instance, baryta, into which the air and the oxygen are introduced by two tubes, while two other apertures give access to the polar wires.

The vessel may thus contain merely air and the necessary excess of oxygen, and the vapors formed by the electric current may be passed directly into the decomposition retort, where steam arrives at the same time.

In another process ammonia is obtained by means of atmospheric nitrogen and watery vapor under the influence of electricity. The apparatus employed for this purpose consists of a retort containing ignited coke, into which is passed watery vapor. The gas (hydrogen) is drawn out by means of a pump, and compressed in a reservoir, where, after being cooled, it may be purified. The gases of combustion derived from heating the retort are driven by a pump into another reservoir, where the carbonic acid is absorbed by lime. From these two reservoirs the nitrogen and hydrogen are led into a chest where they are intimately mixed by a spiral wheel, set in motion by the gaseous current. At the

bottom of the chest is fixed a glass tube containing wires, between which electric sparks play. A cock fixed at the end of the tube serves to regulate the flow of the gas, and the ammonia formed is absorbed by any known means.—*Moniteur des Produits Chimiques.*

THE FOURTH STATE OF MATTER—A REFUTATION.

It may interest the readers of *Science* to know the opinion held in Germany respecting those phenomena which led Mr. W. Crookes to believe he had discovered a fourth state of matter. For this purpose we have translated and abridged an article by Dr. J. Puluj, the well known scientist of Vienna, published in the *Chemiker Zeitung:*

According to Mr. Puluj, the beautiful experiments of W. Hittorf, published in 1869, under the title "Electrical Conductibility of Gases," have received too little attention from our scientists, it may be, on account of the modest title. The scientific labors of Goldstein, and some interesting researches of Reitinger and Urbanitzky have met with the same fate. W. Crookes, the renowned English chemist, to whom the writings of the above-named gentlemen were evidently unknown, made similar experiments, the results of which did not differ essentially from those of Mr. Hittorf. His conclusions were, however, entirely new; he declared that his experiments proved a fourth state of matter.

The conception was daring, still more daring the hopes which he and his friends based upon the discovery of "radiant matter." The cause of these high expectations is the following: When an electrical inductive current is led through a molten glass tube in which the air is attenuated to $\frac{1}{1000}$ of its density, there appears on the negative pole a blue (glimmering) light, which is separated by a dark space from the cluster of light at the positive pole. If a greater attenuation takes place, the cluster of light disappears and the glimmering light floats over the whole tube, while at the same time, next the electrode a second dark space appears, which becomes greater with the greater attenuation. If the attenuation still further increases, the dark space fills the whole tube, and the glass walls shine in a brilliant, green, phosphorescent light. Mr. Crookes now believes that this phenomenon of phosphorescence comes from the remaining gas, which at this high state of attenuation has passed into an ultra-gaseous state, a "fourth state of matter."

But these phenomena are very different at a higher pressure. Direct measurements have shown that the phosphorescence does not appear at the millionth attenuation, and that the thirty thousandth attenuation is sufficient to produce it. Besides, this attenuated gas retains its characteristic properties, which could not be the case if by this attenuation it became dissolved into the original molecules, which form, as Mr. Crookes says, the basis of all.

That the physical properties of this remaining matter are not changed, but remain in strict accordance with the kinetic theory of gases, also proves that we have no new state, but simply a gaseous state of matter. For example, the above mentioned phenomena, in experimenting with the lighter gases, are visible at a lower attenuation than in experimenting with the heavier gases. The supposition of the renowned chemist, Dumas, that our elements are only chemical combinations of higher order, and complicated aggregates of primitive molecules, has, undoubtedly, much probability about it, but even the strongest electrical currents, and the highest temperatures, have not been able to produce this final dissolution of the elements, therefore it is not likely that a high attenuation can.

Dr. Puluj's experiments go to show that Mr. Crookes' so-called radiant matter "consists of negative electric particles," which are torn off from the negative electrode and hurled away with immense rapidity. These electrode particles form a very beautiful metallic mirror on the glass walls. [Aluminum particles are the only ones which form no metallic deposits. This may be accounted for by their chemical constitution.] The conduction of the current, therefore, is effected by the convection of the electrode particles, in which static electricity is accumulated. We have here a case of molecular electric convection, analogous to that observed by Mr. Rowland in his experiments. This gentleman has demonstrated that when a movable horizontally placed metal ring, charged with static, positive or negative, electricity is made to rotate around a vertical axis, it will divert a magnetic needle suspended above it, in the same manner as if an electric positive or negative current were to move in the same direction with, or in an opposite direction from, the rotation. These experiments of Rowland lead to the inference that an infinitely small electrical globe, in our case an electrode particle, will have a similar influence upon a magnet. As long as the globe and magnet are at rest, it is to be expected that no alternate effect will appear, but that this will be produced as soon as the little globe is put into violent motion. Because the electrode particles are negative electric, they represent a positive electric current, which moves in an opposite direction from the former. The electrode particles in motion are, therefore, real elements of an electric current, and are subjected to the law of Laplace. Their deviation takes place according to the following simple law: If we imagine that a plane is placed through the direction of the motion of the electrode particle and through the north pole of the magnet, and suppose that a man is lying upon this electrode particle in the direction of the motion, and looking toward the north pole, then the electrode particle will be diverted toward the left hand of this man, vertical to the imagined plane. This simple law gives a sufficient explanation for all the phenomena which a magnet produces in the radiant electrode matter, and which were observed by Mr. Crookes as well as by Mr. Reitinger and Urbanitzky. It proves that the glimmering light at the negative pole is not a "magnetic" light, but the consequence of a molecular electrical convection, and it justifies the supposition that an electrified current or vapor which is led through a tube will deviate the magnetic needle in the same manner as an electrical current going through a telegraph wire.

The law of the indestructibility of force has already solved many problems which puzzled the scientist of earlier centuries. According to the same law, we must assume that when infinitely small projectiles of radiant electrode matter are hurled against the glass walls of the tube their motion is changed into molecular motion, and the glass walls are heated by the collisions, sometimes even to the melting point, but at a lower temperature the rays which are very much concentrated only produce a phosphorescent light of the glass.

The extremely fine matter called ether, which fills all space and pierces all bodies, surrounds the molecules, as the atmosphere surrounds our globe. Each body and each molecule has in its normal state a certain quantity of this ether. When this quantity is greater than the normal quantity, the molecules, according to the "unitarian view" of elasticity, are positive electric; when it is smaller, they are negative electric.

Supposing now that a collision takes place between the negative electrode particles and the molecules of the glass walls of the tube, then the equilibrium will be restored at each point of collision and the molecules of the glass will lose their surplus of ether. At the same time a motion of the waves of ether will be observed, and this motion is felt by our optical nerves as phosphorescent light. Therefore the phosphorescence observed by W. Crookes is the result of the restoration of the ether equilibrium and not of the heating of the glass, whose temperature during the appearance of this phenomenon is comparatively low.

At a lower degree of attenuation, the stream of electrode matter pushes back the attenuated gas, and this explains the dark space which appears in the tube. This dark space is analogous to the dark space in a gas flame, which is to be seen near the mouth of the gas tube, and is produced because the outstreaming gas pushes back the particles of air which, coming from an opposite direction, try to enter the tube.

. . . .

Another observation of Mr. Puluj also contradicts the conclusions of W. Crookes. Puluj has observed that, at a higher attenuation, the electrode is moving toward the aluminum side, *i. e.*, in opposite direction from that observed by W. Crookes. According to Mr. Crookes the cause of motion is a double one, the higher temperature of the electrode at the metallic side and the emission of electrode particles.

Both effects are opposite. At a lower attenuation the effect of the heat is greater, and the electrode moves in the direction of the wings of the radiometer; with the colder side ahead, at a higher attenuation, the effect of the emission of electrode particles is predominant. Radiant electrode matter and the electrode itself move in the *same* direction.

This remarkable discovery proves not only the incorrectness of Mr. Crookes' explanation, but is also in direct opposition to the principle of the preservation of the center of gravity, which is made by Mr. Crookes the basis of his arguments.

The Vienna scientist draws from his observations the conclusion that the forces by which the electrode particles are torn off are not interior but *exterior* forces. When the electric current passes through the electrode, there is, according to his opinion, really a stream of extremely fine matter (ether) flowing, which not only tears off particles of the electrode, but also sets the whole electrode into motion.

This view seems to be a new proof of the unitarian hypothesis, which maintains that an electric current is nothing else but a current of ether.

Even if the number of scientists who follow the dualistic hypothesis of electricity is by far greater than that of the unitarians, the view of the latter deserves at least our attention, especially when such men as Franklin, Secchi, and Edlund approved it.

ANALYSIS OF VARIOUS AMERICAN TINNED FOOD PRODUCTS.

By G. W. Wigner, F.C.S.

Corned Beef (St. Louis Beef Canning Company). These tins are of a peculiar truncated pyramidal shape, which seemed at first calculated merely to increase the labor of tin making, but when a tin is opened it is found that the shape is advantageous, as the meat readily leaves the tin as if from a mould. The tins are very full, more so indeed than any other I have opened, and this should assist in keeping the meat.

The results of my analysis were as follows:

Moisture		52·23	per cent.
Albuminoid substances		25·44	"
Containing nitrogen	4·07		"
Fat		6·71	"
Ash		4·76	"

The ash contained—

Salt (chloride of sodium)	3	per cent.
Phosphate of lime	0·85	"

It is evident that the meat is only moderately salted; and, considering that it is absolutely free from bone, it contains a very good proportion of phosphates. The moisture is but little more than two-thirds that of raw beef—the fat is less than one-fourth, while the albuminoids are very nearly twice as high. Comparing all the figures, it is a fair estimate to place the dietetic value at nearly twice as high as boneless fresh beef, and about two and one-third times as high as average joints of meat with bone.

The flavor is good. In the smaller tins especially it forms a handy reserve for a cold breakfast or luncheon dish. As to the retail price it appears to vary between 8d. and 10d. per lb. Taking the higher figure, this would correspond to about 4½d. per lb. for good sound meat, a lower price than our poorer classes now pay for the trimmings and refuse of a butcher's shop.

Cooked beef tongue (St. Louis). This is sold in tins, which are very similar to the corned beef ones. As a breakfast dish it is, I think, one of the best of all these tinned goods that I have recently tried. It is certainly superior in this respect to the rolled and pressed tongues, so common, and is, in addition, much cheaper.

The analysis showed:

Moisture		51·58	per cent.
Albuminoid substances		12·15	"
Containing nitrogen	1·92		"
Fat		7·28	"
Ash		6·24	"
Chloride of sodium in ash	4·94		"

This is, therefore, less salted than the average of ordinary dried tongues, and contains more nutritive matter than they do. It is well packed, so that it keeps for some days after the tins are opened.

Tomatoes.—This seems a suitable article to consider with the meat and tongue. I have tried two brands, one Thurbers' and one a French make, with no name on. Both are preserved in water. At first it appeared that this was in excessive quantity, but the whole tin, when analyzed, showed 5·52 per cent. of solid matters. Church gives the solid matter of ripe tomatoes at 10·2 per cent., so that the added water was probably not more than was really needed to fill the tin up when it had been closely packed with the tomatoes. The flavor of most of these has proved excellent, and in no case has there been any objectionable taste.

Soup should, perhaps, have been treated of before meat, but that I have less to say about it. The difficulty I met with has been to find a sample sufficiently mild in flavor. I have tried some half dozen kinds, but all are too strong for my palate; otherwise, as foods, they are certainly nutritious and fairly concentrated; the best of them forming a stiff jelly when cold.

Succotash, a thoroughly American vegetable preparation. It consists of a mixture of Haricot beans, Lima beans, and maize cooked in the tin, and then soldered up; there is also a little fat added. The tin wants simply heating in water before dishing.

The analysis showed:

Water		74·58	per cent.
Albuminoid matters		8·60	"
Containing nitrogen	0·576		"
Cellulose		1·06	"
Ash		0·75	"

It is, therefore, a very good specimen of a boiled vegetable food, and a palatable change from our winter monotony of potatoes and greens.—*The Analyst.*

ON THE EXTRACTION OF IODINE FROM SEA-WEEDS.

By Dr. Thiercelin.

The sea-weeds which serve as sources of iodine are met with in the seas washing the coasts of different countries. The shores of Normandy and Bretagne, certain coasts of Scotland and Ireland, and many other countries which it is unnecessary to mention here, produce numerous sea-plants containing more or less iodine, bromine, and salts of potash.

Our hemisphere does not possess the exclusive privilege of yielding iodiferous plants. Some years ago I had to examine about a hundredweight of saline matter from the coast of Patagonia; these ashes were as rich in iodine and in potash as good Bretagne ashes.

Among all the kinds of sea-weed used in this manufacture, the richest are the two varieties of *Fucus digitatus*, a plant of the deep seas, and which is habitually gathered as drift. When treating plants of this species collected on the northwest coast of Spain, at the southern extremity of the Bay of Biscay, I obtained results so advantageous that I think I ought to make them known.

The arrival of the weeds on the coast depends on the season, the height of the tides, and the disturbance of the atmosphere and the sea. In a general manner, it may be said that the chief gathering of the weeds is in winter; that it is best at the time of high water and especially at the equinoxes.

There are various manners of collecting the weeds: I speak only of that which I have seen in use.

When the tide, after high water, begins to ebb, the weeds which it has brought up are left on the shore. They are then collected and washed a little before the water retires too far.

It is made up in heaps of from half a ton to a ton and carried to the works.

The process of incineration, named the trench process, consists in:

1st. Spreading out the weeds on the sand, or preferably on grass, to dry them.

2d. Burning it in trenches made in the soil and lined with masonry.

This process, among the inconveniences which it presents, has especially the fault of burning the weeds in an irregular manner, calcining one part while the rest is imperfectly burnt, and yielding ashes mixed with much earth and sand. Hence the yield is very irregular, and the iodine very rarely exceeds three parts in the thousand.

Being temporarily intrusted with the management of a works where the returns were far from answering to analytical richness of the weeds, I modified the method of incineration, and it is this alteration which I wish to lay before the society.

Having observed that the species named *Fucus digitatus* is much the most abundant, and at the same time the richest, it was decided to collect this kind only.

As we did not make it a prominent point to dry the plant, we resolved to collect it at all seasons, not forgetting that the proportion of iodine varies with the season, so that from May to September not merely much less weed is to be gathered than from September to May, but that collected in summer yields weight for weight only the third of that obtained in winter.

The weeds being collected, as I have said above, are immediately taken to the furnace-house, weighed, and put in work. The furnace-house is a shed about twenty yards long by six in width. It contains the furnace, a press, pits or holders for the weed, and a space where the ashes produced may be accumulated.

The furnace has the form of a long reverberatory, with the fire in front, and behind it a kind of gallery five yards long and one broad, with a vault two-fifths of a yard in height. The sole of the furnace has a slope of about 12° to the horizon. Upon this furnace follows a drying floor to utilize the waste heat, and, lastly, a chimney ten yards in height. A hole in the shape of a hopper opens at the extremity of the furnace to receive the weeds, and is closed with a plate of sheet-iron. Three side doors serve for working the weeds gradually forwards to the hottest part of the furnace, above which is placed a boiler to receive liquids for evaporation.

If the works are still empty, and if the weeds arrive in abundance, one portion of the weed is placed in the pits and allowed to ferment; another portion is spread out on the furnace top and the drying-floor, and the rest is introduced in the green state into the furnace by the hopper. The charge of green weed is about half a ton, and a little water is put into the boiler against the juice of the weed is ready, to prevent the iron plates from burning.

The fire is then kindled, and we obtain: 1. A partial drying of the weeds spread on the furnace-top and on the drying-floor annexed. 2. A more complete desiccation in the interior of the furnace. The weeds are then raked downward, and as the heat becomes more intense the dry leaves take fire. When this result is obtained, the hottest parts are drawn into an ash-pit which runs the whole length of the furnace. The combustion which began in the furnace is here completed; it goes on slowly and is continued by reason of the fresh supplies which are continually thrown upon the first.

While room is thus made in the furnace, owing to the desiccation and ignition, fresh quantities of dried weed are introduced through the hopper, taken from the drying-floor and the furnace top, and green weed is spread out to dry in their place. After the work has once commenced, it never ceases except from lack of weeds.

In the meantime the weeds placed in the pits undergo the

alcoholic fermentation, so that at one time I hoped to collect and utilize the alcohol. However, putrid fermentation sets in after four or five days, and I have never found more than 1 per cent. of alcohol in the liquid.

After fermentation for four, five, or six days the weeds are put under the press, and the juice is thus separated from the cakes. The juice is evaporated to dryness in the boiler above the furnace. The flakes of dried liquid are then placed in the furnace beyond the bridge. The press-cakes are placed successively on the drying-floor and in the furnace, and yield ash like the unpressed weed.

Is the fermentation necessary? I believe that it is, at least, very useful, since it is said to prevent the formation of a volatile cyanide of iodine, which would occasion a loss of this substance. In any case I have recourse to it only when the stock of weed is too great for the furnace to take up without waiting.

If we compare this method with that of incineration in pits, it will be seen:

1. That the drying is done away with under circumstances where it is very difficult—on the seashore and in the winter season.

2. That we may substantially count upon getting all the iodine contained in the weeds. Thus, if in the summer, we only obtain 5 per 1,000, or ½ per cent. of iodine, in winter we get 14 or even 15 per 1,000, = 1 2-5th, or even 1½ per cent., at a time when the yield is greater and when drying would be impracticable.

3. The extraction of iodine and of potash from the light ashes obtained by this process is much easier than from the residues of the common process, which are hard as stones, and require a long time and much hot water for lixiviation.—*Bulletin de la Soc. Chemique de Paris.*

ARTIFICIAL INDIGO.

ACCORDING to the *Moniteur Industriel*, M. Auerbach has devised a process for an alizarine *blue* destined to serve as a substitute for indigo. One part of dried mononitro-alizarine is mixed with five parts of sulphuric acid, and half a part of glycerine at 52½° Tw., and heated moderately. The reaction begins at 224° F. and becomes violent, the temperature rising to 392° F. A violent ebullition sets in and sulphurous acid and acroleine are given off. When the ebullition has ceased the entire mass is plunged into water, boiled, and filtered. The residue is boiled three or four times with dilute sulphuric acid. The filtrates are mixed and let cool, and the coloring matter separates out in the form of brown crystals. These crystals are purified by mixing them with water and adding borax until the solution becomes of a brownish violet; the blue forms an insoluble compound with the boracic acid. This residue is washed and decomposed with an acid, and the blue is then obtained in the form of a silky violet paste. If the product is expected to be perfectly pure it must be successively recrystallized from solution in heavy naphtha, in amylic alcohol, and glacial acetic acid. When it is pure it appears in the form of brown, brilliant needles.—*Chemical Review.*

PITTACAL.

THIS beautiful dye, which is also known under the names of eupittonic acid, and corn-flower blue, according to R. Gottheil, is obtained as follows:

That part of the oil of wood-tar which is heavier than water is repeatedly distilled and then heated with about 25 per cent. of alkali. After the indifferent oils have been separated the hot alkaline solution is mixed with 25 per cent. of common salt. When cold the dimethyl-ethers of pyrogallic acid and of methylpyrogallic acid separate out as a crystalline mass, which is then stirred up with five times its volume of a solution of soda containing 20 per cent. After the liquid has been heated to a boil a current of air is forced through it till the liquid becomes entirely blue. The aqueous solution of the eupittonate of potash that is formed is filtered hot, and the acid is precipitated in the free state by the addition of muriatic acid. It is purified by repeated conversion of the acid into the soda salt, which is sparingly soluble in the cold, washing it in solution of common salt and reprecipitation.

"AZO" DYES.

THE following catalogue of the so-called azo coloring matters, by Professor Otto N. Witt, of Mulhouse, is translated from the *Chemiker Zeitung*, and will throw a valuable light on the names, properties, and sources of these dyewares.

In testing these colors two reactions are generally sufficient—the first, which can be applied on the fiber, consists in noting the coloration produced by concentrated sulphuric acid, and the change of such coloration on dilution with water; the second test consists in observing the form and solubility of the lime salts.

A.—BASIC AZO-DYES, NOT CONTAINING SULPHUR.

1. Chrysoidine, prepared from diazobenzol chloride and phenylendiamine, becomes yellow if sprinkled upon concentrated sulphuric acid; on dilution with water it turns first red, but afterwards an orange yellow; solutions containing 4-5 per cent. chrysoidine congeal on cooling to a blood-red jelly.

2. Phenylen brown (Manchester brown, Bismarck brown, or Vesuvine) is obtained by treating the muriate of phenylendiamine with salts of nitrous acid. It dissolves in sulphuric acid with a black-brown color, which becomes orange on dilution.

B.—ACID AZO-DYES, DERIVATIVES OF SULPHANILIC ACID.

3. Tropæoline Y, a product of the reaction with phenol; a pale yellow powder, which dissolves in concentrated sulphuric acid with a brownish yellow color, but becomes a pure yellow on dilution. The aqueous solution gives a finely crystalline white precipitate on the addition of chloride of calcium.

4. Tropæoline O (chrysoine, chryseoline), a derivative of resorcine. The solution in sulphuric acid is yellow, and on adding chloride of calcium there is a deposit of golden yellow scales.

5. Tropæoline OO (orange IV., Jaune d'Aniline), a derivative of diphenylamine. Dissolves in oil of vitriol with an intense violet blue, but becomes reddish violet on dilution. The lime salt is white and quite insoluble.

6. Gold orange (orange III., tropæoline D, helianthine), a derivative of dimethylaniline. Dissolves in oil of vitriol with a yellowish brown, becoming a pure splendid red on dilution. This color is permanent even if extremely diluted. The lime salt consists of sparingly soluble iridescent scales. Sold as a salt of ammonia.

7. Tropæoline OOO, No. 1 (orange I.). A derivative of *a*-naphthol. A reddish-brown powder or iridescent green crystals. Dissolves in oil of vitriol with a reddish-violet, turning red on dilution.

8. Tropæoline OOO, No. 2 (orange II.; *b*-naphthol orange, chrysaureine), a red powder. Dissolves in oil of vitriol with a magenta-red, but turning orange on dilution. The lime salt is readily soluble in hot water.

C.—COLORS CLOSELY CONNECTED WITH THE GROUP B, BUT DIFFERENT IN THEIR PREPARATION.

9. Echt Gelb. Fast yellow (Grässler's patent); obtained by sulphurizing amidoazobenzol. Dissolves in concentrated sulphuric acid with a yellow color, turning a salmon-red on dilution.

10. Jaune N (Poirrier's), closely connected with tropæoline OO. The solution in oil of vitriol is green, becoming blue on dilution, and finally violet.

11. Orange G. (Meister, Lucius, and Brüning). Dissolves in oil of vitriol with an orange color, which does not alter on dilution.

D.—DERIVATIVES OF THE NAPHTHIONIC ACIDS (SULPHO-NAPHTHYLAMINIC ACIDS).

13. Rocelline (orseilline No. 3, rubidine, fast red and rauracienne). A product of the action of diazonaphthionic acid upon *b*-naphthol. First made by Poirrier, then by Williams, Thomas, and Dower, and some months later by the Baden Aniline and Soda Company. Dissolves in oil of vitriol with a violet blue, like tropæoline OO; turns brown and turbid on dilution. The lime salt is insoluble, red-brown, and gelatinous.

Rocelline mixed with *b*-naphthol orange (No. 8) forms the so-called rouge français. Naphthol-orange is much used in mixtures, *e. g.*, with eosine scarlet.

E.—DERIVATIVES OF B-NAPHTHOLDISULPHURIC ACID.

(Meister, Lucius, and Brüning's Patent.)

Of the many dyes of this kind introduced into the market by this firm, the more important are here mentioned.

14. Ponceau G. (Yellowish scarlet.)

15. Ponceau R. (Reddish scarlet.)

These are products of the action of diazoxylol upon the salts G and R of the above-mentioned patent.

16. Ponceau RR.

17. Ponceau RRR, products of the reaction of higher homologues of diazoxylol upon the same salts.

The solution of the last four dyes in sulphuric acid is red, with a yellowish tone; no change on dilution.

18. Bordeaux, product of the reaction of diazonaphthaline upon *b*-disulphonaphtholic acid. Dissolves in sulphuric acid with an indigo blue color, which turns violet on dilution.

19. Coccinine. Dissolves in oil of vitriol with a bluish-red; pure red on dilution. Here belongs "ponceau suextra," a mixture of acid magenta, with a ponceau obtained from *b*-disulphonaphtholic acid.

F.—TETRA-AZO DYES.

20. Biebrich scarlet. The result of the action of the diazo-compound of fast yellow with *b*-naphthol-soda. Dissolves in oil of vitriol with a splendid emerald green, which turns blue, violet, red, and is finally precipitated. This last feature is a distinction from saffranine, which undergoes the same change of color.

The derivatives of picramic acid, orseilline 1 and 2, have not been adopted in the trade.—*Chemical Review.*

A NEW METHOD FOR DETERMINING THE VALUE OF ZINC POWDER.

By V. DREWSEN.

THE author prepares two solutions: the one of pure fused potassic dichromate, say 40 grammes per 1,000 c.c.; and the other of crystalline ferrous sulphate, about 200 grammes in 1,000 c.c. The iron solution must be strongly acidulated with sulphuric acid, to prevent oxidation. In order to find the respective value of the two liquids, 10 c.c. of the iron solution are measured into a beaker, a little sulphuric acid is added, and the other solution is dropped in from a burette until a drop of the mixture is no longer turned blue by potassic ferricyanide. About 1 gramme of the zinc powder is then weighed, placed in a beaker with 100 c.c. of the chromic solution, 10 c.c. of dilute sulphuric acid are added, the whole is well stirred, 10 c.c. more of the sulphuric acid are added, and allowed to act for about a quarter of an hour with diligent stirring. When everything is dissolved except a small insoluble residue, an excess of sulphuric acid is added, and 50 c.c. of the iron solution in order to reduce the greater part of the excess of chromate; more of the iron solution is then added from a burette till a drop displays a distinct blue reaction with ferricyanide, and the mixture is then titrated back with chromate till this reaction disappears. From the total number of c.c. of the iron solution consumed the quantity is deducted which corresponds to the ferrous solution employed. The chromate contained in the remainder, if multiplied by 0·66113, shows the metallic zinc contained in the powder.

ZINC IN SPRING WATERS.

By E. MYLIUS.

IN cases where iron is absent the author proposes the following colorimetric method: 2·60 grammes potassic ferrocyanide are made up to 100 c.c., and 3·536 grammes zinc sulphate to 1,000 c.c., so that 1 c.c. of the latter solution contains 1 mg. ZnO. Into a test glass of about 4 cm. in width there are poured 200 c.c. of the water to be examined, which should be clear and filtered. In another glass are placed 200 c.c. of spring water free from zinc. To each is added an equal quantity, which may be from five to eight drops of hydrochloric acid, and 2 c.c. of the solution of ferrocyanide. To the water free from zinc there is then added from a narrow burette, drop by drop, so much of the zinc solution as will render the turbidity equal to that in the water containing zinc. After this preliminary experiment a cylindrical glass is again charged with 200 c.c. of the water to be examined, 2 c.c. of the ferrocyanide solution, and eight drops of hydrochloric acid. Five other glasses are then charged each with 200 c.c. of water free from zinc, ferrocyanide, and acid as before, and different quantities of the zinc solution. All the cylinders are then allowed to stand for half an hour, protected from too full daylight, and the turbidities produced are then examined. The author remarks that the parish well at Tuttendorf, which contains 0·007 gr. ZnO per liter, has been used for drinking for about a century without any perceptible injury.

ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF SCIENCE.

THE meeting for 1880 took place at Boston, Mass., August 25. The most extensive arrangements had been made by the citizens of Boston for the reception of the members, and from first to last they were entertained in an almost royal manner. Free excursion tickets to all places in the vicinity, and even as far as the White Mountains and return, were provided; also lodgings and daily lunches.

The meeting was called to order by the retiring President, Prof. Geo. F. Barker, who at once resigned the chair to the new President, the Hon. Lewis H. Morgan, of Rochester, N. Y.

In the present and following numbers of our SUPPLEMENT we shall give some of the most interesting papers that were read before the Association. The reports of the Boston *Daily Advertiser* were excellent, and from its columns we take several papers.

THE PROBLEM OF LIFE.

was the subject of the address of PROF. GEO. F. BARKER, of Philadelphia, on his retirement from the Presidency of the Association.

In the course of his remarks he said:

An important fact concerning nervous action is that its amount may be measured by the quantity of blood consumed in its performance. Dr. Mosso, of Turin, has devised an apparatus called the plethysmograph—drawings of which were exhibited at the London Apparatus Exhibition of 1876—designed for measuring the volume of an organ. The forearm, for example, being the organ to be experimented on, is placed in a cylinder of water and tightly inclosed. A rubber tube connects the interior of the cylinder with the recording apparatus. With the electric circuit by which the stimulus was applied to produce contraction were two keys, one of which was a dummy. It was noticed that, after using the active key several times, producing varying current strengths, the curve sank as before on pressing down the inactive key. Since no real effect was produced, the result was caused solely by the imagination, blood passing from the body to the brain in the act. To test further the effect of mental action, Dr. Pagliani, whose arm was in the apparatus, was requested to multiply 267 by 8, mentally, and to make a sign when he had finished. The recorded curve showed very distinctly how much more blood the brain took to perform the operation. Hence the plethysmograph is capable of measuring the relative amount of mental power required by different persons to work out the same mental problem. Indeed, Mr. Gaskell suggests the use of this instrument in the examination room, to find out, in addition to the amount of knowledge a man possesses, how much effort it causes him to produce any particular result of brain work. Dr. Mosso relates that while the apparatus was set up in his room in Turin, a classical man came in to see him. He looked very contemptuously upon it and asked of what use it could be, saying that it couldn't do anybody any good. Dr. Mosso replied, "Well, now, I can tell you by that whether you can read Greek as easily as you can Latin." As the classicist would not believe it, his own arm was put into the apparatus and he was given a Latin book to read. A very slight sinking of the curve was the result. The Latin book was then taken away and a Greek book was given him. This produced immediately a much deeper curve. He had asserted before that it was quite as easy for him to read Greek as Latin, and that there was no difficulty in doing either. Dr. Mosso, however, was able to show him that he was laboring under a delusion. Again, this apparatus is so sensitive as to be useful for ascertaining how much a person is dreaming. When Dr. Pagliani went to sleep in the apparatus, the effect upon the resulting curve was very marked indeed. He said afterward that he had been in a sound sleep and remembered nothing of what passed in the room—that he had been absolutely unconscious; and yet every little movement in the room, such as the slamming of a door, the barking of a dog, and even the knocking down of a bit of glass, were all marked on the curves. Sometimes he moved his lips and gave other evidences that he was dreaming; they were all recorded on the curve, the amount of blood required for dreaming diminishing that in the extremities. The emotions too left a record. When only a student came into the room, little or no effect appeared in the curve. But when Professor Ludwig himself came in, the arteries in the arm of the person in the apparatus contracted quite as strongly as upon a very decided electrical stimulation.

In an address of the retiring President of this association, delivered a few years ago, I find this sentence: "Thought cannot be a physical force, because thought admits of no measure." In the light of the rapid advances lately made in investigating mental action we see that in two directions at least, in its rate of action and of its relative energy, we may already measure thought, as we measure any other form of energy, by the effect it produces.

Chemistry tells us that complexity of composition involves complexity of properties. The grand progress which organic chemistry has made in recent times has been owing to the distinct recognition of the influence of structure upon properties. Isomerism is one of its most significant developments. The number of possible isomers increases enormously with the complexity of the molecule. Granted that we now know several of the proteid group of substances—how many thousands may there be yet to know? Bodies of such extreme complexity of constitution may well have an indefinite number of isomers. Not only does chemistry not say that there cannot be such a thing, but she encourages the expectation that there will yet be found the precise proteid of which the changes of protoplasm are properties. The rapid march of recent organic synthesis makes it quite certain that every distinct chemical substance of the living body will ultimately be produced in the laboratory, and this from inorganic materials. Given only the exact constitution of a compound, and its synthesis follows. When, therefore, the chemist shall succeed in producing a mass constitutionally identical with protoplasmic albumen, there is every reason to expect that it will exhibit all the phenomena which characterize its life, and this equally whether protoplasm be a single substance or a mixture of several closely allied substances.

That matter in the crystalloid and colloid forms may be chemically identical, differing only in the size of its molecule, may be quite possible. But it is also possible that the difference may be a physical one. To produce the colloid state from the crystalloid is by no means beyond the power of science. We qualify our previous statement, then, only so far as to say that when the chemist produces a body in the colloidal form, having the identical constitution of protoplasm, there is every reason to believe that it will have the properties of protoplasm. The important question now arises whether, since the protoplasm of animals is identical

with that of vegetables, and the latter is the food of the former, any protoplasm whatever is vitalized by the animal as such. That this identity exists would seem satisfactorily established. Though the protoplasm of vegetables is inclosed within a cellulose bag, it is only a closely imprisoned rhizopod. A still more striking evidence of this intimate relationship has been developed by Darwin in his researches upon insectivorous plants. Not only do these plants possess a mechanism for capturing insects, but they secrete a gastric juice which digests them.

Another most curious proof of the identity of animal and vegetable protoplasm has been given by Claude Bernard, who has shown that both are alike sensitive to the influence of anæsthetics. A sensitive plant exposed to ether no longer closed its leaflets when touched. Assimilation and growth, as well as germination, are arrested by chloroform. The yeast plant when etherized no longer decomposes sugar to produce alcohol and carbon dioxide; while the inversive and non-vital ferment still acts to convert the cane-sugar into glucose; precisely as under these circumstances the diastasic ferment converts the starch of the seed into sugar. By arresting anæsthetically the process by which carbon dioxide is absorbed and oxygen evolved, the true respiratory process, being less affected, now appears and Schutzenberger has proved that the fresh cells of the yeast plant breathe like an aquatic animal. It would seem then that the protoplasmic life of animals is identical with that of plants; a certain measure of destructive metamorphosis taking place in each, evolving energy and producing carbon-dioxide and water. When, however, this function is examined quantitatively, its maximum is seen to be reached in the animal. While the assimilative function characterizes the plant, the destructive function distinguishes the animal. Hence it is the function of the plant to store up energy to produce the highly complex protoplasm. This, consumed by the animal as his food, continues his existence as a living being, the energy gradually set free by its successive steps of retrogressive metamorphosis appearing as the work which he performs. If this view be correct it would follow that every individual substance found in the animal—save only those which result from degradation—must be found in the plant upon which it feeds, and this is the fact. The evidence, then, would seem conclusive that, since the protoplasm of the animal and vegetable kingdoms is identical, the former in all cases being derived from the latter, the animal as such neither produces nor vitalizes any protoplasm.

Two inferences seem naturally to follow from this conclusion. First, that all the properties of animal protoplasm and of the animal organism of which it constitutes the essential part must have previous existence in the plant; second, that hence the solution of the life question in the myxomycetes will solve the life problem for the highest vertebrate.

PRACTICAL APICULTURE.

An excellent paper read by PROF. A. J. COOK, who said:

The study of bees has always proved interesting to those who have attempted to raise them, but it becomes far more so when the work is undertaken in the spirit of scientific investigation. The peculiar characters which distinguish the drones, the workers, and the solitary queen of the hive were set forth in a very instructive manner. The queen bee lays three or four eggs per minute, and may deposit as many as 4,000 eggs in a single day. Aristotle was right when he designated the queen as the mother, but Virgil was wrong in calling her a king. The enmity which always exists between queens induces swarming, and although in swarming the queen never leads, she usually determines the place of clustering. If the queen does not leave the hive the swarm will return.

Huber asserted that the queen always mates on the wing, and this can readily be proved by clipping the wing of a virgin queen so as to render flight impossible. This experiment also proves that the drones are the result of what is known as agamic reproduction—reproduction without fertilization—for the eggs produced by a virgin queen always produce drones. Wagner thought that the unimpregnated eggs were placed in the large cells and the fertilized eggs in the smaller cells, and he supposed this was the result of automatic action during the deposition of the eggs. He advanced the idea that in depositing the eggs in the small cells a pressure was exerted upon the abdomen of the queen in such a manner as to cause the fertilizing fluid to be expelled from its receptacle, and that this did not take place in the case of the large cells.

However, later investigations have shown that well fertilized eggs may be deposited in the still larger queen cells. The structure of the queen also indicates that the kind of eggs which she lays is purely a matter of volition, and many facts support this evidence. It is well known that only a few impregnated eggs, among the many, produce queen bees. This curious fact seems to be caused by the quality and quantity of food that they receive. The queen bee seems to be produced by rich and abundant food from a cell which, under ordinary circumstances, would produce a worker. Queens may be produced in the ordinary cells, but full-sized queens require larger cells in which to complete their growth. The queen's only function is to lay eggs, and they may continue to do so for five successive years, but usually the period of their activity only extends over one or two years. The drones are males; they eat much and do nothing but exercise their sexual functions. They are always produced by the queen while in the virgin state.

The worker-bees, in seasons of adversity, when nectar is scanty in supply, will sometimes kill all the drones. The worker-bees, as would be inferred from what has already been said, are imperfectly developed females—immature—owing to the limited quantity of food which they received in the larval state. If the hive be deprived of a queen, some of the workers will become fertile, but from the eggs which they deposit only drones will develop.

It has recently been observed that, under ordinary circumstances, the old bees gather the honey and pollen, while the younger ones remain in the hive and secrete wax, build the comb, feed the brood, and cap the cells. Two colonies of bees will not readily unite if brought together. Each seems to detect the other by the sense of smell, for if both colonies be sprinkled with the same perfume they will then unite. It is a curious fact that bees seem to be guided in their flight by direction rather than by sight. If a hive be moved a few feet from its usual position, the bees, on returning, will go directly to the original position, and then turn at a sharp angle to reach their destination. This they will continue to do for days. Honey was placed on a porch of a house, about five rods distant from another house precisely like it. Many bees swarmed around the house where there was no honey.

The paper concluded with a brief account of the enemies of bees, of which there are a number known to practical bee keepers, and a reference to some recent inventions for the removal of honey from the comb. The honey extractor removes the honey by centrifugal force, and by its use honey may be removed before the comb is capped. Thus we are enabled to use the same combs over and over again, and this enables the bees to furnish twice as much honey as they otherwise could. The comb is also now made artificially out of pure beeswax, and the bees accept it as a perfect substitute for combs of their own make.

LIGHTNING BUGS.

Some very interesting ideas were presented in the paper of PROF. JOHN L. LECONTE, of Philadelphia. Our knowledge of the manner in which the light is produced is very meager—in truth, we can only theorize about it, for the conditions under which it is given out are very peculiar, and require much further investigation. According to our present theory of light, a high temperature is necessary for its production, and our theory does not explain the fact that the lightning bugs, the glow worms, and the fire flies can produce light at such low temperatures as they do. The few observations that have been made by means of the spectroscope show that the light of the insects mentioned gives a continuous spectrum; quite rich in the blue or more refrangible rays. Such a spectrum, according to the theory of light that is quite generally accepted by physicists of the present time, can only be produced by heating solid matter until it becomes incandescent. There is a difference of opinion among entomologists as to whether the manifestation of light is under the control of the will of the insect, as maintained by Prof. Leconte, or whether it is quite involuntary. Some observers say that when the light is brightest the abdomen can be observed to move, and they consider that the movement excites the luminosity.

OAK GALLS.

Many specimens were exhibited and described by Mr. H. F. BASSET. Galls are produced by insects, which deposit their eggs in the tissues of the plant, where they hatch at the proper season and set free the larvæ. Around the spot where the eggs are deposited the galls develop, and afford an excellent protective covering. Just what leads to the growth of the galls is not fully understood. It is supposed that some kind of an irritation is caused, either by a poisonous fluid which is deposited by the wasp where the eggs are laid, or, as Prof. Riley believes, in some cases by irritation produced by the movements of the larvæ after they are hatched. The question was discussed by several members, who assumed different attitudes in regard to the subject.

FRICTION OF LUBRICATING OILS.

MR. C. J. WOODBURY, inspector for the Boston Manufacturers' Mutual Fire Insurance Company, discussed the "Friction of Lubricating Oils," of which an abstract is given below: The resistance existing between bodies of fixed matter moving with different velocities or directions presents itself in the form of a passive force, which results in the diminution or destruction of opponent motion. Modern science has demonstrated that this destruction is only apparent, being merely the conversion of the force of the moving body into the oscillation of the resisting obstacle or into that molecular vibration which is recognized as heat. Direct friction refers to the case where the two bodies are in actual contact, and mediate friction where a film of lubricant is interposed between the surfaces, and it is this which applies to nearly every motion in mechanics where bodies slide upon each other. The coefficient of friction is the relation which the pressure upon moving surfaces bears to resistance. Mr. Woodbury limited his discussion to a description of the apparatus for measuring the friction of lubricating oils, the method of its use and the results obtained with a number of oils in the market which are used for lubricating spindles. Previous investigation of nine different oil-testing machines used showed that none of them could yield consistent duplicate results in furnishing the coefficient of friction. The paper mentioned the circumstances which must be known or preserved constant—temperature, velocity, pressure, area of frictional surfaces, thickness of the film of oil between the surfaces, and the mechanical effect of the friction. The radiation of heat generated by friction must be reduced to a minimum, and no oil should be allowed to escape till subjected to attrition. Therefore a dynamometer is required which is instantaneous and automatic in its action. Mr. Woodbury described in detail the construction of his instrument and the mode of its operation, which was too elaborate to be reproduced in an abstract. The operation of the machine under equal conditions with the same oil gives results which are as closely consistent with each other as could be expected from such physical measurements. Much of the slight irregularity was due to the variable speed of the engine. The results were remarkably uniform, but they do not agree with the laws of friction, as given in works on mechanics, but the coefficient of friction varies in an inverse ratio with the pressure. Friction varies as the area, because the adhesiveness of the lubricant is proportional to the area, and the resistance due to this cause is a larger fraction of the total mechanical effect with light than with heavy pressures. The lubricant used is one of the most important factors in the cost of power. In the present condition of engineering science it is impossible to state what exact proportion of the power used by a mill is lost in sliding friction, but in a print-cloth mill only about 25 per cent. of the power is utilized in the actual processes of carding, spinning, and weaving the fiber, not including the machinery engaged in the operation, leaving 75 per cent. of the power as absorbed by the rigidity of the belts, the resistance of the air, and friction. Mr. Woodbury concludes that the successful operation of a spinning frame is far more closely dependent upon the individual management in respect to the conditions of band tension, lubrication, and temperature of the spinning room than all other causes combined. Not that some forms of spindle are not superior to others, but without wise supervision the most desirable forms of spindle must fail to show the merits due to the skill of their promoter. The lubricating qualities of an oil are inversely proportional to its viscosity; the endurance of a lubricant is, in some degree, proportional to its adhesion to the surfaces forming the journal. An ideal lubricant, in these respects, would be a fluid whose molecules had a minimum cohesion for each other, and a maximum adhesion for metallic surfaces. Viscous oils adhere more strongly to metal surfaces, hence it is obligatory to use such thick lubricants on heavy bearings. With light pressures more fluid oils are admissible, and in all cases the oils should be as limpid as possible. Oils with great endurance are likely to give great frictional resistance, and in the endeavor to save gallons of oil many a manager has wasted tons of coal. The true solution of the problem of lubricating machinery is to ascertain the consumption of oil and the expenditure of power, both being measured by the same unit, namely, dollars. Mr. Woodbury detailed his experiments in measuring the fluidity of oils; omitted their endurance, because consumption of oil varies with temperature, and gave the data for determining the safety and efficiency of a lubricant.

THE PHOTOPHONE.

By ALEXANDER GRAHAM BELL.

IN bringing before you some discoveries made by Mr. Sumner Tainter and myself, which have resulted in the construction of apparatus for the production and reproduction of sound by means of light, it is necessary to explain the state of knowledge which formed the starting point of our experiments. I shall first describe the remarkable substance selenium, and the manipulations devised by various experimenters; but the final result of our researches has evidenced the class of substances sensitive to light vibrations, until we can propound the fact of such sensitiveness being a general property of all matter. We have found this property in gold, silver, platinum, iron, steel, brass, copper, zinc, lead, antimony, German silver, Jenkins' metal, Babbitt's metal, ivory, celluloid, gutta percha, hard rubber, soft vulcanized rubber, paper, parchment, wood, mica, and silvered glass; and the only substances from which we have not obtained results are carbon and thin microscopic glass. We find that when a vibratory beam of light falls upon these substances they emit sounds—the pitch of which depends upon the frequency of the vibratory change in the light. We find farther that, when we control the form or character of the light-vibration on selenium, and probably on the other substances, we control the quality of the sound and obtain all varieties of articulate speech. We can thus, without a conducting wire as in electric telephony, speak from station to station, wherever we can project a beam of light. We have not had opportunity of testing the limit to which this photophonic influence can be extended, but we have spoken to and from points 213 meters apart; and there seems no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another. The necessary privacy of our experiments hitherto has alone prevented any attempts at determining the extreme distance at which this new method of vocal communication will be available. I shall now speak of selenium.

SELENIUM.

In the year 1817 Berzelius and Gottlieb Gahn made an examination of the method of preparing sulphuric acid in use at Gripsholm. During the course of this examination, they observed in the acid a sediment of a partly reddish, partly clear brown color, which, under the action of the blow-pipe, gave out a peculiar odor, like that attributed by Klaproth to tellurium. As tellurium was a substance of extreme rarity, Berzelius attempted its production from this deposit; but he was unable after many experiments, to obtain further indications of its presence. He found plentiful signs of sulphur mixed with mercury, copper, zinc, iron, arsenic and lead, but no trace of tellurium. It was not in the nature of Berzelius to be disheartened by this result. In science every failure advances the boundary of knowledge as well as every success, and Berzelius felt that, if the characteristic odor that had been observed did not proceed from tellurium, it might possibly indicate the presence of some substance then unknown to the chemist. Urged on by this hope he returned with renewed ardor to his work. He collected a great quantity of the material, and submitted the whole mass to various chemical processes. He succeeded in separating successively the sulphur, the mercury, the copper, the tin, and the other known substances whose presence had been indicated by his tests—and, after all these had been eliminated, there still remained a residue which proved upon examination to be what he had been in search of—a new elementary substance. The chemical properties of this new element were found to resemble those of tellurium in so remarkable a degree that Berzelius gave to the substance the name of "selenium," from the Greek word *selene*, the moon—("tellurium," as is well known, being derived from *tellus*, the earth).

Although tellurium and selenium are alike in many respects, they differ in their electrical properties; tellurium being a good conductor of electricity, and selenium, as Berzelius showed, a non-conductor. Knox discovered, in 1837, that selenium became a conductor when fused; and Hittorff, in 1852, showed that it conducted, at ordinary temperatures, when in one of its allotropic forms. When selenium is rapidly cooled from a fused condition it is a non-conductor. In this, its vitreous form, it is of a dark-brown color, almost black by reflected light, having an exceedingly brilliant surface. In thin films it is transparent, and appears of a beautiful ruby red by transmitted light. When selenium is cooled from a fused condition with extreme slowness, it presents an entirely different appearance, being of a dull lead color, and having throughout a granulated or crystalline structure, and looking like a metal. In this form it is perfectly opaque to light, even in very thin films. This variety of selenium has long been known as "granular" or "crystalline" selenium, or, as Regnault called it, "metallic" selenium. It was selenium of this kind that Hittorff found to be a conductor of electricity at ordinary temperatures. He also found that its resistance to the passage of an electrical current diminished continuously by heating up to the point of fusion, and that the resistance suddenly increased in passing from the solid to the liquid condition. It was early discovered that exposure to sunlight hastens the change of selenium from one allotropic form to another; and this observation is significant in the light of recent discoveries.

EXPERIMENTS WITH SELENIUM.

Although selenium has been known for the last sixty years, it has not yet been utilized to any extent in the arts, and it is still considered simply as a chemical curiosity. It is usually supplied in the form of cylindrical bars. These bars are sometimes found to be in the metallic condition, but more usually they are in the vitreous or non-conducting form. It occurred to Willoughby Smith that, on account of the high resistance of crystalline selenium, it might be usefully employed at the short end of a submarine cable in his system of testing and signaling during the process of submersion. Upon experiment the selenium was found to have all the resistance required—some of the bars employed measuring as much as 1,400 megohms—a resistance equivalent to that which would be offered by a telegraph wire

long enough to reach from the earth to the sun! But the resistance was found to be extremely variable. Experiments were made to ascertain the cause of this variability. Mr. May, Mr. Willoughby Smith's assistant, discovered that the resistance was less when the selenium was exposed to light than when it was in the dark.

In order to be certain that temperature had nothing to do with the effect, the selenium was placed in a vessel of water, so that the light had to pass through from one to two inches of water in order to reach the selenium. The approach of a lighted candle was found to be sufficient to cause a marked deflection of the needle of the galvanometer connected with the selenium, and the lighting of a piece of magnesium wire caused the selenium to measure less than half the resistance it did the moment before.

These results were naturally at first received by scientific men with some incredulity, but they were verified by Sale, Draper, Moss, and others. When selenium is exposed to the action of the solar spectrum the maximum effect is produced, according to Sale, just outside the red end of the spectrum, in a point nearly coincident with the maximum of the heat rays; but, according to Adams, the maximum effect is produced in the greenish-yellow or most luminous part of the spectrum. Lord Rosse exposed selenium to the action of non-luminous radiations from hot bodies, but could produce no effect; whereas a thermopile under similar circumstances gave abundant indications of a current. He also cut off the heat rays from luminous bodies by the interposition of liquid solutions, such as alum, between the selenium and the source of light, without affecting the power of the light to reduce the resistance of the selenium; whereas the interposition of these same substances almost completely neutralized the effect upon the thermopile. Adams found that selenium was sensitive to the cold light of the moon, and Werner Siemens discovered that, in certain extremely sensitive varieties of selenium, heat and light produced opposite effects. In Siemens' experiments special arrangements were made for the purpose of reducing the resistance of the selenium employed. Two fine platinum wires were coiled together in the shape of a double flat spiral in the zigzag shape, and were laid upon a plate of mica so that the disks did not touch one another. A drop of melted selenium was then placed upon the platinum wire arrangement, and a second sheet of mica was pressed upon the selenium, so as to cause it to spread out and fill the spaces between the wires. Each cell was about the size of a silver dime. The selenium cells were then placed in a paraffine bath and exposed for some hours to a temperature of 210° C., after which they were allowed to cool with extreme slowness. The results obtained with these cells were very extraordinary; in some cases the resistance of the cells, when exposed to light, was only one-fifteenth of their resistance in the dark.

Without dwelling further upon the researches of others, I may say that the chief information concerning the effect of light upon the conductivity of selenium will be found under the names of Willoughby Smith, Lieutenant Sale, Draper, and Moss, Professor W. G. Adams, Lord Rosse, Day, Sabini, Dr. Werner Siemens, and Dr. C. W. Siemens. All observations by these various authors had been made by means of galvanometers; but it occurred to me that the telephone, from its extreme sensitiveness to electrical influences, might be substituted with advantage. Upon consideration of the subject, however, I saw that the experiments could not be conducted in the ordinary way, for the following reason: The law of audibility of the telephone is precisely analogous to the law of electric induction. No effect is produced during the passage of a continuous and steady current. It is only at the moment of change from a stronger to a weaker state, or *vice versa*, that any audible effect is produced, and the amount of effect is exactly proportional to the amount of variation in the current. It was, therefore, evident that the telephone could only respond to the effect produced in selenium at the moment of change from light to darkness, or *vice versa*; and that it would be advisable to intermit the light with great rapidity, so as to produce a succession of changes in the conductivity of the selenium, corresponding in frequency to musical vibrations within the limits of the sense of hearing. For I had often noticed that currents of electricity, so feeble as to produce scarcely any audible effects from a telephone when the circuit was simply opened or closed, caused very perceptible musical sounds when the circuit was rapidly interrupted, and that the higher the pitch of sound the more audible was the effect. I was much struck by the idea of producing sound by the action of light in this way. Upon further consideration it appeared to me that all the audible effects obtained from varieties of electricity could also be produced by variations of light acting upon selenium. I saw that the effect could be produced at the extreme distance at which selenium would respond to the action of a luminous body, but that this distance could be indefinitely increased by the use of a parallel beam of light, so that we could telephone from one place to another without the necessity of a conducting wire between the transmitter and receiver. It was evidently necessary, in order to reduce this idea to practice, to devise an apparatus to be operated by the voice of a speaker, by which variations could be produced in a parallel beam of light corresponding to the variations in the air produced by the voice.

EXPERIMENT WITH LIGHT AS A PRODUCER OF SOUND.

I proposed to pass light through a large number of small orifices, which might be of any convenient shape, but were preferably in the form of slits. Two similarly perforated plates were to be employed. One was to be fixed and the other attached to the center of a diaphragm actuated by the voice, so that the vibration of the diaphragm would cause the movable plate to slide to and fro over the surface of the fixed plate, thus alternately enlarging and contracting the free orifices for the passage of light. In this way the voice of a speaker could control the amount of light passed through the perforated plates without completely obstructing its passage. This apparatus was to be placed in the path of a parallel beam of light, and the undulatory beam emerging from the apparatus could be received at some distant place upon a lens, or other apparatus, by means of which it could be condensed upon a sensitive piece of selenium placed in a local circuit with a telephone and galvanic battery. The variations in the light produced by the voice of the speaker should cause corresponding variations in the electrical resistance of the selenium employed; and the telephone in circuit with it should reproduce audibly the tones and articulations of the speaker's voice. I obtained some selenium for the purpose of producing the apparatus shown; but found that its resistance was almost infinitely greater than that of any telephone that had been constructed, and I was unable to obtain any audible effects by the action of light. I believed, however, that the obstacle could be overcome by devising mechanical arrangements for reducing the resistance of the selenium, and by constructing special telephones for the purpose. I felt so much confidence in this that, in a lecture delivered before the Royal Institute of Great Britain, upon the 17th of May, 1878, I announced the possibility of hearing a shadow by interrupting the action of light upon selenium. A few days afterward my ideas upon this subject received a fresh impetus by the announcement made by Mr. Willoughby Smith before the Society of Telegraph Engineers that he had heard the action of a ray of light falling upon a bar of crystalline selenium, by listening to a telephone in circuit with it.

It is not unlikely that the publicity given to the speaking telephone during the last few years may have suggested to many minds in different parts of the world somewhat similar ideas to my own.

Although the idea of producing and reproducing sound by the action of light, as described above, was an entirely original and independent conception of my own, I recognize the fact that the knowledge necessary for its conception has been disseminated throughout the civilized world, and that the idea may, therefore, have occurred to many other minds. *The fundamental idea, on which rests the possibility of producing speech by the action of light, is the conception of what may be termed an undulatory beam of light in contradistinction to a merely intermittent one.* By an undulatory beam of light, I mean a beam that shines continuously upon the selenium receiver but the intensity of which upon that receiver is subject to rapid changes, corresponding to the changes in the vibratory movement of a particle of air during the transmission of a sound of definite quality through the atmosphere. The curve that would graphically represent the changes of light would be similar in shape to that representing the movement of the air. I do not know whether this conception had been clearly realized by "J. F. W.," of Kew or by Mr. Sargent, of Philadelphia but to Mr. David Brown, of London, is undoubtedly due the honor of having distinctly and independently formulated the conception, and of having devised apparatus—though of a crude nature—for carrying it into execution. It is greatly due to the genius and perseverance of my friend, Mr. Sumner Tainter, of Watertown, Mass., that the problem of producing and reproducing sound by the agency of light has at last been successfully solved.

RESEARCHES BY MR. SUMNER TAINTER AND DR. A. GRAHAM BELL.

The first point to which we devoted our attention was the reduction of the resistance of crystalline selenium within manageable limits. The resistance of selenium cells employed by former experimenters was measured in millions of ohms, and we do not know of any record of a selenium cell measuring less than 250,000 ohms in the dark. *We have succeeded in producing sensitive selenium cells measuring only 300 ohms in the dark, and 155 ohms in the light.* All former experimenters seemed to have used platinum for the conducting part of their selenium cells, excepting Werner Siemens, who found that iron and copper might be employed. We have also discovered that brass, although chemically acted upon by selenium, forms an excellent and convenient material; indeed, we are inclined to believe that the chemical action between the brass and selenium has contributed to the low resistance of our cells by forming an intimate bond of union between the selenium and brass. We have observed that melted selenium behaves to the other substances as water to a greasy substance, and we are inclined to think that when selenium is used in connection with metals not chemically acted upon by it, the points of contact between selenium and the metal offer a considerable amount of resistance to the passage of a galvanic current. By using brass we have been enabled to construct a large number of selenium cells of different forms. The mode of applying the selenium is as follows: The cell is heated, and when hot enough a stick of selenium is rubbed over the surface. In order to acquire conductivity and sensitiveness, the selenium must next undergo a process of annealing.

We simply heat the selenium over a gas stove and observe its appearance. When the selenium attains a certain temperature, the beautiful reflecting surface becomes dimmed. A cloudiness gradually extends over it, somewhat like the film of moisture produced by breathing upon a mirror. This appearance gradually increases, and the whole surface is soon seen to be in the metallic granular or crystalline condition. The cell may then be taken off the stove, and cooled in any suitable way. When the heating process is carried too far, the crystalline selenium is seen to melt. Our best results have been obtained by heating the selenium until it crystallizes, and continuing the heating until signs of melting appear, when the gas is immediately put out. The portions that had melted instantly recrystallize, and the selenium is found upon cooling to be a conductor, and to be sensitive to light. The whole operation occupies only a few minutes. This method has not only the advantage of being expeditious, but it proves that many of the accepted theories on this subject are fallacious Our new method shows that fusion is unnecessary; that conductivity and sensitiveness can be produced without long heating and slow cooling: and that crystallization takes place during the heating process. We have found that on removing the source of heat immediately on the appearance of the cloudiness, distinct and separate crystals can be observed under the microscope, which appear like leaden snow-flakes on ground of ruby red. Upon removing the heat, when crystallization is further advanced, we perceive under the microscope masses of these crystals arranged like basaltic columns standing detached from one another; and at a still higher point of heating, the distinct columns are no longer traceable, but the whole mass resembles metallic pudding stone, with here and there a separate snow-flake, like a fossil, on the surface. Selenium crystals formed during slow cooling after fusion present an entirely different appearance, showing distinct facets.

PHOTOPHONIC TRANSMITTERS.

We have devised about fifty forms of apparatus for varying a beam of light in the manner required, but only a few typical varieties need be shown. The source of light may be controlled or a steady beam may be modified at any point in its path. The beam may be controlled in many ways. For instance, it may be polarized and then affected by electrical or magnetic influences in the manner discovered by Faraday and Dr. Ker. The beam of polarized light, instead of being passed through a liquid, may be reflected from the polished pole of an electro-magnet. Another method of affecting a beam of light is to pass it through a lens of variable focus. I observe that a lens of this kind has been invented in France by Dr. Cusco, and is fully described in a recent paper in *La Nature*, but Mr. Tainter and I have used such a lens in our experiments for months past. The best and simplest form of apparatus for producing the effect remains to be described. This consists of a plane mirror of flexible material—such as silvered mica or microscope glass. Against the back of this mirror the speaker's voice is directed. The light reflected from this mirror is thus thrown into vibrations corresponding to those of the diaphragm itself.

ARRANGEMENT OF APPARATUS FOR THE REPRODUCTION OF SOUND BY LIGHT.

In arranging the apparatus for the purpose of reproducing sound at a distance, any powerful source of light may be used, but we have experimented chiefly with sunlight. For this purpose a large beam is concentrated by means of a lens upon the diaphragm mirror and after reflection is again rendered parallel by means of another lens. The beam is received at a distant station upon a parabolic reflector, in the focus of which is placed a sensitive selenium cell, connected in a local circuit with a battery and telephone. A large number of trials of this apparatus have been made with the transmitting and receiving instruments so far apart that sounds could not be heard directly through the air. In illustration I shall describe one of the most recent of these experiments. Mr. Tainter operated the transmitting instrument, which was placed on the top of the Franklin schoolhouse in Washington, and the sensitive receiver was arranged in one of the windows of my laboratory, 1325 L street, at a distance of 213 meters. Upon placing the telephone to my ear I heard distinctly from the illuminated receiver the words: "Mr. Bell, if you hear what I say, come to the window and wave your hat." In laboratory experiments the transmitting and receiving instruments are necessarily within earshot of one another, and we have, therefore, been accustomed to pooling the electric circuit connected with the selenium receiver, so as to place the telephones in another room. By such experiments we have found that articulate speech can be reproduced by the oxyhydrogen light, and even by the light of a kerosene lamp. The loudest effects obtained from light are produced by rapidly interrupting the beam by the perforated disk. The great advantage of this form of apparatus for experimental work is the noiselessness of its rotation, admitting the close approach of the receiver without interfering with the audibility of the effect heard from the latter; for it will be understood that musical tones are emitted from the receiver when no sound is made at the transmitter. A silent motion thus produces a sound. In this way musical tones have been heard even from the light of a candle. When distant effects are sought, another apparatus is used. By placing an opaque screen near the rotating disk, the beam can be entirely cut off by a slight motion of the hand, and musical signals like the dots and dashes of the Morse telegraph code can thus be produced at the distant receiving station.

We have made experiments with the object of ascertaining the nature of the rays that affect selenium. For this purpose we have placed in the path of an intermittent beam various absorbing substances. Professor Cross has been kind enough to give me his assistance in conducting these experiments. When a solution of alum or bisulphide of carbon is employed, the loudness of the sound produced by the intermittent beam is very slightly diminished; but a solution of iodine in bisulphide of carbon cuts off most, but not all, of the audible effect. Even an apparently opaque sheet of hard rubber does not entirely do this. When the sheet of hard rubber was held near the disk interrupter, the rotation of the disk interrupted what was then an invisible beam, which passed over a space of about twelve feet before it reached the lens, which finally concentrated it upon the selenium cell. A faint but perfectly perceptible musical tone was heard from the telephone connected with the selenium. This could be interrupted at will by placing the hand in the path of the invisible beam. It would be premature, without further experiments, to speculate too much concerning the nature of these invisible rays, but it is difficult to believe that they can be heat rays, as the effect is produced through two sheets of hard rubber containing between them a saturated solution of alum Although effects are produced as above shown by forms of radiant energy which are invisible, we have named the apparatus for the production and reproduction of sound in this way "The Photophone," because an ordinary beam of light contains the rays which are operative.

NON-ELECTRIC PHOTOPHONE RECEIVERS.

It is a well known fact that the molecular disturbance produced in a mass of iron by the magnetizing influence of an intermittent electrical current can be observed as sound by placing the ear in close contact with the iron. It occurred to us that the molecular disturbance produced in crystalline selenium by the action of an intermittent beam of light should be audible in a similar manner without the aid of a telephone or battery. Many experiments were made to verify this theory without definite results. The anomalous behavior of the hard rubber screen suggested the thought of listening to it also. This experiment was tried with extraordinary success. I held the sheet in close contact with my ear, while a beam of intermittent light was focused upon it by a lens. A distinct musical note was immediately heard. We found the effect intensified by arranging the sheet of hard rubber as a diaphragm, and listening through a hearing tube. We then tried crystalline selenium in the form of a thin disk, and obtained a similar but less intense effect. The other substances which I enumerated at the beginning of my address were now successively tried in the form of thin disks, and sounds were obtained from all but carbon and thin glass. We found hard rubber to produce a louder sound than any other substance we tried, excepting antimony, and paper and mica to produce the weakest sounds. *On the whole, we feel warranted in announcing as our conclusion that sounds can be produced by the action of a variable light from substances of all kinds, when in the form of thin diaphragms.* We have heard from interrupted sunlight very perceptible musical tones through tubes of ordinary vulcanized rubber, of brass, and of wood. These were all the materials at hand in tubular form, and we have had no opportunity since of extending the observations to other substances.

I am extremely glad that I have the opportunity of making the first publication of these researches before a scientific society, for it is from scientific men that my work of the last six years has received its earliest and kindest recognition. I gratefully remember the encouragement which I received from the late Professor Henry at a time when the speaking telephone existed only in theory. Indeed, it is greatly due to the stimulus of his appreciation that the telephone became an accomplished fact. I cannot state too highly also the advantage I received in preliminary experiments on sound vibrations in this building from Professor

Cross, and near here from my valued friend Dr. Clarence J. Blake. When the public were incredulous of the possibility of electrical speech, the American Academy of Arts and Sciences, the Philosophical Society of Washington, and the Essex Institute of Salem recognized the reality of the results and honored me by their congratulations. The public interest, I think, was first awakened by the judgment of the very eminent scientific men before whom the telephone was exhibited in Philadelphia, and by the address of Sir William Thomson before the British Association for the Advancement of Science.

At a later period, when even practical telegraphers considered the telephone as a mere scientific toy, Professor John Peirce, Professor Eli W. Blake, Dr. Channing, Mr. Clarke, and Mr. Jones, of Providence, R. I., devoted themselves to a series of experiments for the purpose of assisting me in making the telephone of practical utility; and they communicated to me, from time to time, the result of their experiments with a kindness and generosity I can never forget. It is not only pleasant to remember these things and to speak of them, but it is a duty to repeat them, as they give a practical reputation to the often repeated stories of the blindness of scientific men to unaccredited novelties, and of their jealousy of unknown inventors who dare to enter the charmed circle of science. I trust that the scientific favor which was so readily accorded to the telephone may be extended by you to this new claimant, the photophone.

ATMOSPHERIC BACTERIA.

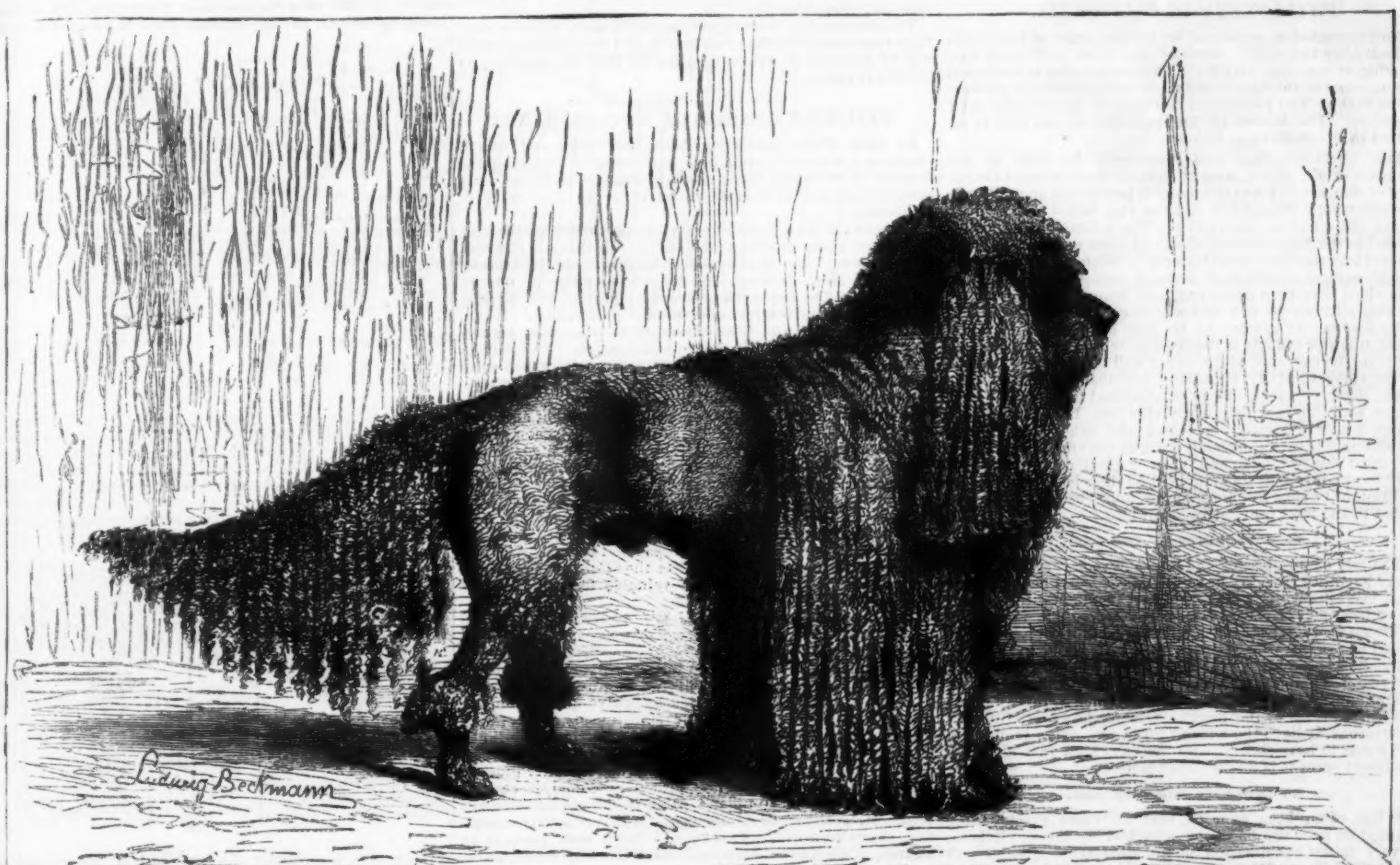
By P. MIQUEL.

THE number of atmospheric bacteria is low in winter, rises in spring, reaches its maximum in summer and autumn, and falls rapidly with the first frosts. This law is equally applicable to the spores of fungi. But while the mould germs are most abundant in damp weather, the aerial bacteria are then rare, and become most numerous when the ground is dry. Until it shall be possible to prepare a liquid capable of causing the germs of all schizophytes to germinate indiscriminately, it will be very difficult to find with accuracy the number of bacteria suspended in the air. On operating with neutral broth perfectly sterilized the mean annual number of bacteria found in a cubic meter of air does not exceed 200, which would lead us to believe that the atmosphere is a hundred times richer in spores of moulds than in germs of bacteria. In summer and autumn we find occasionally at Montsouris 1,000 germs of bacteria per cubic meter of air. In winter it is not rare to see this number fall to 4 or 5, and to notice days where the dust of 200 liters of air is incapable of setting up infection, even in the most susceptible liquids. In the interior of houses, in the absence of mechanical causes which stir up dust, 30 to 50 liters are required to determine infection. In the author's laboratory 5 liters are sufficient to infect neutral broth. 1 liter of air from the sewers of Paris is enough to occasion a similar result. It will be seen how widely these results differ from those published by Prof. Tyndall. According to this savant a few c.c. of air are generally sufficient to introduce infection into the most various liquids. The author has compared the mortality in Paris due to infectious diseases with the number of bacteria present in the air. From this comparison, carried on from December, 1879, to June, 1880, it appears that every increase of atmospheric bacteria is followed in about eight days with an increase of the deaths from this class of diseases. Prolonged observation must prove whether this fact is anything more than a coincidence.

A GERMAN CORDED POODLE.

WE give an illustration from the Illustrated London *News* of the famous blood poodle Nero, which was distinguished with the first prize of this class at the recent Berlin International Dog Show. It is drawn from life by L. Beckmann, of Dusseldorf, who acted also as judge of this class. Nero is, perhaps, the finest and most perfect specimen of the German corded-coated poodle that was ever bred. The ringlets of his woolly and glossy coat form long pendulous strings or cords, which are twisted as regularly as if done by aid of artificial means. On the shoulders these ringlets are of the length of more than twenty-six inches, and when the dog is moving about his long, waving coat gives him the appearance of walking under a black mourning drapery. The shaven parts of the body show that the frame of a good poodle of this breed is beautiful and well made, like that of a high bred sporting dog.

In our SCIENTIFIC AMERICAN SUPPLEMENT, No. 244, we gave a full page of illustrations of the principal prize dogs shown at the above Exhibition, with interesting particulars as to breeds and other exhibits.



NERO, A GERMAN CORDED-COATED POODLE, AT THE RECENT BERLIN INTERNATIONAL DOG SHOW.

THE PERCHERON HORSE.

THE PERCHERON HORSE is thus described by the distinguished French author, Charles Du Huys, in his report to the French Government:

"Almost everything that has been written about the horse may be reduced pretty much to complaining that there does not exist a breed which unites, in an elevated degree, high moral to physical qualities; modestly seeking, and teaching the means of obtaining such a breed.

"It is reasonable that such sentiments should surprise us here in the heart of France, where for a long time a race of horses has flourished which may be said to fill the requirements proposed in every way. The proof of this statement is easy; a hasty sketch of the principal characters of the breed suffices to furnish it. To no ordinary strength, to vigor which does not degenerate, and to a conformation which does not exclude elegance, it joins docility, mildness, patience, honesty, great kindness, excellent health, and a hardy, elastic temperament.

"Its movements are quick, spirited, and light. It exhibits great endurance, both when hard worked and when forced to maintain for a long time any of its natural gaits, and it possesses the inestimable quality of moving fast with heavy loads. It is particularly valuable for its astonishing precocity, and produces by its work, as a two-year old, more than the cost of its feed and keep; indeed, it loves and shows a real aptitude for labor, which is the lot of all. It knows neither the whims of bad humor nor nervous excitement. It bears for man, the champion of its labors, an innate confidence, and expresses to him a gentle familiarity, the fruits of an education for many generations in the midst of his family. Women and children, from whose hands it is fed, can approach it without fear; in a word, if I may dare to speak thus, *it is an honorable race*. It has that fine Oriental gray coat, the best adapted of all to withstand the burning rays of the sun in the midst of the fields—a coat which pleases the eye, and which, in the darkness of the night, allowed the postilion of former times to see that he was not alone—that his friend was making his way loyally before him. It is exempt (a cause of everlasting jealousy among the breeders of other races), always exempt from the hereditary bony defects of the hock; and where it is raised, spavin, jardons, bone spavin, periodical inflammation, and other dreaded infirmities are not even known by name.

"This truly typical race would seem a myth did it not exist in our midst. But every day we see, every day we handle this treasure—the magnificent gift of Providence to this favored region, to cause agriculture, that 'nursing mother,' to flourish, and with agriculture, peace and abundance.

"I need not name this breed; every one from this incomplete sketch has recognized the fine race of steady and laborious horses, bred in the ancient province of Perche (so justly entitled *Perche of good horses*), plowing in long furrows the soil of Beauce, and thence spreading itself over all France, where its qualities render it without a rival for all the specialities of rapid draught.

"Hence it is that all our provinces envy us the possession of the race, and even foreign countries seek after it with an eagerness amounting to a passion."

FELIDÆ IN CAPTIVITY.

As the Felidæ family comprises some of the most valuable and interesting animals to be found in the zoological gardens and menageries, their treatment in captivity is of great importance. It is impossible, in view of their confinement and consequently limited opportunities of exercise, for them to have all the conditions of life favorable to health. Constipation is one of the serious difficulties we have to contend with. To guard against this, liver is fed them once a week; when this proves ineffectual, castor oil is administered with their meat. Their food is either beef or horse flesh, the latter being used altogether in the Zoological Garden of Philadelphia, and in the principal European gardens, as a measure of economy. Old and worn-out horses are taken to the gardens, where a veterinary surgeon examines them to ascertain if they are free from disease. In some gardens the mode of killing these horses is by a blow on the head, as this retains the blood through the meat. Regularity as to time of feeding is of importance. We feed once on week days only, and fast on Sunday, in order to avoid surfeiting and to give the stomach a rest. The animals understand this perfectly; for while at the approach of the feeding hour during the week, they pace their cage impatiently watching for the keeper, on Sunday they give no sign of expectation, but remain quiet in their cage. I have had instances of animals voluntarily abstaining from food for a period of ten days without suffering apparent inconvenience. In cases of this kind I try to tempt their appetite with a live rabbit or chicken, or other delicate morsel. The tiger and lion are allowed for one meal twelve to fifteen pounds of meat, including bone; the smaller animals less, in proportion to their size. When the meal is finished water is given to them, after which they pace the cage for a while and then sleep. They are all very fond of catnip, and when it is placed in their cage, enjoy rolling in it, thus resembling the domestic cat. It is advisable to place logs of wood in the cage, so that the animal may scratch with its claws; otherwise the nails will grow into the flesh and fester, causing much pain, and will have to be cut from time to time. The felidæ live in captivity from fifteen to sixteen years, showing signs of decay at about the age of twelve. The lion seems to breed more freely than any other species of felidæ; and, strange to say, that in traveling menageries they breed as freely as in gardens where the cages are more spacious. This may be attributed to the change of air and scene in their circus life. The jaguar and leopard have been crossed, also the tiger and lion. Specimens of the latter were exhibited last year in this city by Mr. Forepaugh in his traveling managerie. Period of gestation in the lion, tiger, and hyena, sixteen weeks; leopard, fifteen weeks; panther, thirteen weeks. The

number at a birth is usually from two to four, in the case of the lion an hour or two intervening between the delivery of each cub. The last time a hyena at the menagerie gave birth to young there was an interval of twenty-four hours between each cub. Weight of lion cubs when born, four to six pounds. Hyena three and a quarter pounds. Eyes open after from four to seven days, and in three weeks teeth all cut. The young of the spotted hyena are born without spots, while those of the self-colored animals, lion and panther, are born with spots which disappear in from three to four months. The young of the tiger and leopard are marked like the adult, but of course less distinctly. It frequently happens that the mother will devour her young, but after the cubs are three or four weeks old there is no further danger. The tiger cubs are generally taken from their mother as soon as born and given to a bitch to bring up. Our cubs at the menagerie suffer chiefly from rickets, which affects them when about six or eight months old. As a remedy for this we give lime, and have used calcis phosphorus precipitate with good results. We have a lioness at the Park Menagerie that has bred twenty-seven cubs in seven years, and raised but one. Mr. Bartlett, in a paper read before the London Zoological Society, says: "A very extraordinary malformation or defect has frequently occurred among lions produced during the last twenty years in the Regent's Park. This imperfection consists in the roof of the mouth being opened; the palatal bones do not meet; the animal, therefore, is unable to suck, and consequently dies. This abnormal condition has not been confined to any one pair of lions, but many lions that have bred in the garden and not in any way related to each other have from time to time produced these malformed young, the cause of which appears to me quite unaccountable.—*W. A. Conkling, in Archives of Comparative Medicine and Surgery.*

PHYLLOXERA IN CALIFORNIA.

THE commission appointed by the Governor of California to look after the vine interests of the State held their first meeting at Sonoma, July 22. The commission is composed of a number of the largest and most successful grape growers of the State. The phylloxera has thus far received the chief attention. The history of the progress of the pest is reported in the *Bulletin* as follows:

The phylloxera was first discovered in 1865 in the vineyard of Mr. Goess, a short distance northwest of the village of Sonoma. From this point it has spread up and down the valley for a distance of eight or nine miles and a width of one and a half to three miles. The infected districts now extend to the Napa County line, and some experts assert has crossed into the edge of that county. Within the limits mentioned, several hundreds of acres of once thrifty and valuable vines have been destroyed, and many acres more are making a feeble growth and will succumb entirely in another season. It appears to be only a question of a few years, unless a remedy is discovered, when all of the vineyards on the east side of the valley will be utterly destroyed. In the vineyard of Mr. Haraszthy, and that of another owner to the south, is a tract of one hundred and fifty acres of land in one body, upon which every vine has been killed, and which is now cultivated in wheat and other farm crops. Adjoining this tract thousands more of the vines are infested, and their scanty foliage and meager crop of grapes show only too plainly that this year will be their last, and that an addition of twenty-five acres more must be uprooted and added to the tract previously mentioned.

SLOW PROGRESS OF THE PEST.

The rate of progress of the insect is not very rapid. In many localities from six to eight rows of vines had sickened since last season, showing a progress from an infected center of from fifty to seventy-five feet. It has taken a period of fifteen years to traverse a distance of nine or ten miles, which is a slower rate of progress than is made in France, where it has been known to spread a distance of sixty miles in one year. This slow rate of progress is thought by Professor Hilgard and others to be due to the absence in this State of the winged form of the insect. Others, however, for various reasons, believe the winged form does exist, though no one seems to have seen it, and that the slow rate at which the insect spreads is due to other causes.

NO IMMUNITY FOR RICH SOIL.

It has often been asserted that no vines except those planted on poor soil had been attacked by the phylloxera. A very casual examination of the devastated district will show the fallacy of this reasoning. Undoubtedly the more vigorous the vine the better able it is to withstand the attack, and the longer it will resist. But it is certain that thousands of the most thrifty vines, growing upon fine, deep soil, have been killed. Neither does the age of the vine seem to make any difference, the old as well as the young being equally subject to attack, vines five and six years old, and others twenty years of age, in several instances being equally infested.

After a vine is attacked, a period of from three to five years elapses before it succumbs. The first year the appearance of the vine shows little change, but the second or third year the enfeebled growth and scanty crop is quite apparent, while the following year it either sends out six inches or a foot of sickly growth, or fails to start at all. Sometimes a vine will look quite thrifty, and produce fifteen or twenty pounds of grapes one season and fail to put forth a single bud the next. It is often difficult for even the practiced eye to detect the infested vines when first attacked. In fact, the roots carried to the hall to-day for exhibition, and upon which could be seen thousands of the insects, were taken from vines that to the ordinary observer seemed perfectly healthy, though grown near to those in the last stages of decadence. It has become a well-established fact that the insect deserts the roots of the vine the year before it dies for fresh pastures on those of the adjoining vines, so that one who is hunting the insect must look upon the roots of apparently healthy plants to find them.

RESTORING NATIVE AMERICAN VINES.

After years of investigation and experiment, the French have found that most American vines resist the attacks of the insect to a certain extent, and that all of those varieties which belong to the *Æstivalis* and *Cordifolia* species are entirely uninjured by it. Therefore, by planting these vines, and grafting into them their own choice kinds, they have a means of restoring their lost vineyards. The favorite variety in France, and the one sent there in the greatest quantities, is the Lenoir, called also Jacquez and Black Spanish. Of this vine millions of cuttings are being shipped from the Southern States, principally from Texas. Probably the reason this vine is looked upon with so much favor is that its fruit makes a very passable dark-colored wine, and therefore is being largely grown ungrafted.

Messrs. Dresel and Gundlach are planting the Taylor and Elvira varieties of the *Cordifolia* family from Missouri, and are grafting into them the Zinfindel, Riessling, Chasselas, and other favorite varieties of *Vitus vinifera*. At Mr. Dresel's vineyard the visitors had an opportunity of seeing large plantings of these two Eastern vines which have been grafted, besides large quantities of cuttings planted in nursery rows to be rooted. A few mission vines had been grafted with the Elvira, and although the scions had been inserted but sixteen months, there was a very fair showing of fruit and a good growth of wood. Mr. Dresel has tried on quite an extensive scale grafting the cuttings before planting, but finds so large a proportion of the grafts fail to grow that he does not advise that method, preferring to insert the grafts after the cuttings have stood one year and made roots, either in the nursery rows or in the vineyard.

A quantity of infested roots were obtained from Mr. Haraszthy's vineyard, and carried back to the hall at the village for exhibition. To the naked eye the clusters of phylloxera on these roots looked like yellowish dust or mildew, but under a moderate magnifying power they were resolved into myriads of repulsive looking oval bugs of a semi-transparent greenish-yellow color, each having six legs, two antennæ, and two black eyes. Dr. Bleasdale exhibited with his microscope mounted specimens from France, as well as the living Sonoma insects, showing that the two are identical.

Since this report was printed Professor Hilgard, of the State University, has been compelled to admit the presence of the winged variety in California. In a lot of seven winged phylloxera recently sent to him from the Sonoma Valley, by Dr. J. C. Hyde, he has discovered two of a fertile variety. This unfortunately settles in the affirmative the question of possible affection at a distance, and Professor Hilgard urges effective steps to check the pest, as has been done in Fresno County.

The threatening character of the phylloxera invasion was fully appreciated by the commission, and energetic measures will be adopted to prevent, so far as may be possible, its further ravages.

VALUABLE GRASSES OF NEW ZEALAND.

IN view of the increasing faith in grasses and forage plants as a source of profit and as a means of restoring the fertility of worn-out lands, the San Francisco *Bulletin* has been casting about for new grasses likely to be of value to California.

Some of the New Zealand grasses in particular are thought to deserve close attention and study. Hooker's "Flora of New Zealand," and Buchanan's "Manual of the Indigenous Grasses of New Zealand," are the chief sources of our information. The last work is issued as part of the government survey, and is a rare and valuable publication. It contains descriptions and illustrations of no less than eighty-seven species, arranged in twenty-eight genera. The *Bulletin* selects such species only as appear to be worth growing in California. The information is likely to be of value also to other parts of our broad land.

A fine pasture grass, growing well both on light and sand soils and on heavy clays, is the meadow rice grass of the colonists (*Microlæna stipiodes*). The sweet-scented sacred grass (*Hierochæ redolens*) grows in wet places and on sand hills near the sea, often reaching a height of four feet. It is not as valuable fodder as some others, but is still very useful to the settlers. *Spinifex hirsuta*, in combination with the foregoing, would be worth much to bind fast the drifting sands on our coasts. It is propagated both by seed and by roots. Among native Millets the *Panicum distichum* grows in wet bottoms, and is a valuable lowland grass of easy growth.

The large family of *Panicums* are otherwise represented by only worthless species, but we may say in passing that *P. spectabile*, of Brazil, and *P. frumentaceum* of India, both of much value, have been introduced there and thrive beyond expectation. They will not endure severe frosts. The genus *Agrostis* is represented by twelve species, some of great value to the farmers and stock-raisers, and found growing at various elevations, even above the snow lines. *A. canina* is a perennial, and is known in many countries. Though hardy and useful, there are, however, better grasses. *A. parviflora*, or slender grass, also a perennial, is equally hardy, and adapted to upland pastures, giving late summer feed. *A. muelleri*, or Alpine grass, is best adapted to mountain sheep pastures. *A. æmula*, a tooth bent grass, is an annual, often six feet high, and much liked by cattle, growing on strong soils and also in the shade of trees. *A. pilosa* is perennial on lowlands, and furnishes nearly constant feed. One of the best of the *Agrostis* family is, however the *A. stelifolia*, a close-growing, succulent grass, which is hardy and deserves sowing in any pasture, particularly on the mountain slopes. Another perennial of note is *A. avenoides*. Concerning this family of grasses a writer says that they all possess value for pasturing, but must not be overstocked, or they inevitably run out.

One of the curious families of the grasses is the genus *Arundo*, to which our Pampas grass belongs. They are coarse and tall-growing plants, but if properly cured some species yield an immense quantity of average fodder. The New Zealand species *A. conspicua*, or plumed tussac grass, is of great value for cattle during the winter months, and it is thought that it would repay cultivation. Another tussac grass is *Poa foliosa*, a large, littoral, perennial grass, growing three feet high, and is very fattening food for cattle. It is somewhat like the famous Falkland Island "tussock grass." There are seven or eight other species of *Poas*, all perennial, and all affording large supplies of food. Some of these are of dwarf growth, and others are quite as large as the Pampas grass. *P. Colensoi*, which is five leaved and ten inches in height, and *P. intermedia*, of similar nature, are among the most prized of New Zealand grasses. *P. uniflora* is sub-alpine, tufted, twenty inches in height, and of good quality.

Found at isolated places in New Zealand islands, is a species of millet, which, however, botanists have put in a new class and named *Isache australis*, a native of swamps, and a most valuable pasture grass, worthy of wide cultivation on account of its heavy yield.

Dichelachne crinita, a wiry tuft-grass, is noted for flattening stock, and makes a large bulk of hay. It also does best on moist land.

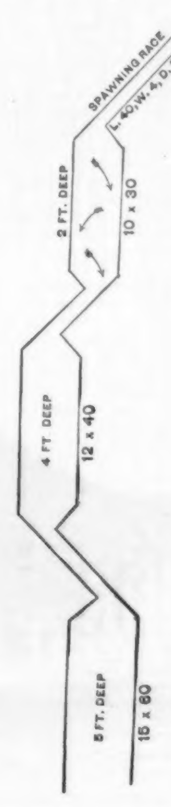
A peculiar rigid, creeping grass, *Zoysia pungens*, makes a compact turf on salty lands, sea shores, and on sand hills. It clothes wet flats with greensward, and drives out weeds and other grasses. The *Apera arundia*, or wind grass, is highly ornamental, and is used for paper-making, but is not good for pasture. Rat-tail grass (*Sporobolus indicus*) is also useful for paper-making, but its peculiar quality is that it kills out all other vegetation, even the native ferns and wild flax. It is a good grass for cattle and horses but not for sheep. For road sides no better grass could be found.

The genus *Danthonia* contains many interesting grasses, some of which are eight feet high, while others are of creeping habit. Many are perfectly hardy and deserve cultivation. They take care of themselves, and increase rapidly. Nearly all are tussac or clump-growing grasses, and therefore perennial. *D. cunninghami*, *D. ovata*, *D. raoulii*, *D. flavescens*, and *D. buchanani*, are some of the best species, all good fodder plants, affording much shelter to cattle in exposed places. The Danthonias possess a large butter-making capacity, and are valuable grasses for the dairyman.

Trisetum antarcticum, also a hardy perennial, one or two feet high, is an important element in the native pastures, and *T. youngii* is of Alpine habits, wide-leaved and succulent. The genus Festuca, which is of wide-world distribution, finds in New Zealand some varieties, such as *F. littoralis*, which have the capacity of binding the sands. *F. scoparia* is fine for sheep pastures. *F. duriuscula* thrives in all situations, stands dry weather well, and is of good quality.

HOW TO MAKE TROUT PONDS.

OF the various forms of ponds that have been advocated, from Seth Green's pear shape, Fred. Mathers' oblong square, to the Eldridge, Elmira, pleasure park ovals and circles, none have been found to meet all the needful conditions so well as the long and narrow, or canal shape, from four to six times as long and broad, and not more than eight or ten feet wide, in any case, unless the water supply is very copious. For the purpose of spawning and trout raising, a series of three ponds is desirable, that the just hatched fry, the half grown and the table fish, may be separated and protected; and for this purpose their proportion and arrangement, as shown in the diagram (that is, *en echelon*, as the



French say), is probably the very best, if the ground will admit of it. The water flows from one to the other at an angle, so that there may be a current from side to side as the banks are impinged upon by its flow. It is desirable that there should be a fall of a foot or less into the lower ponds, but the two upper into which the spawning race flows, should be but little lower than the spring.

Here it may be as well to say that a suitable spring is the first requisite in trout hatching and raising. It should be cold, pure, constant, and the more abundant the better. One affording ten to twenty gallons a minute would serve for raising many thousand trout, and a much smaller one would suffice for home use. Mr. Ainsworth, of your State, has raised a very large number from a spring that furnished a stream the size of a goose quill; but the larger the supply the better even for a limited number of trout. The spring should be walled up so high as to exclude all surface wash, and the margins of the various ponds should be raised for the same purpose. Some fish culturists advocate walled up ponds, but earth banks are far preferable, and much cheaper. They should slope sufficiently to allow the earth to lie securely, and if grass is permitted to grow to the water's edge, all the better, as it affords hiding places for the smaller fish, and attracts insects for their sustenance. The bottoms of the ponds should be V-shaped, to admit of being easily drained, and may be of the prevailing hard pan, clay, or sand; but gravel is not desirable, unless you wish the trout to make their spawning beds there. The spawning race proper may be of any convenient length, and not so deep as to prevent a free flow of water over the gravel at the bottom. If screens, as invented by Mr. Ainsworth, are used to collect the spawn, there need be no gravel except upon the upper screen, and there it should be very coarse, the size of robins' eggs or larger, if the spawners are over a pound in weight. If screens are not used, the gravel is needed in the race to decoy the ripe fish, which may be netted and stripped in the usual manner.

Of the hatching house it is needless here to speak, except to say that many of the cumbrous fixtures formerly in use—hatching troughs of great length, etc.—have given place to a very simple contrivance in which the water flows in at the bottom of a tank of any convenient shape and depth, up through a series of screens on which the eggs are placed,

thus freeing them of all sediment, and doing the work with the greatest ease and certainty.

Ponds may be of any size other than those of the diagram as the water supply will warrant. It is not well to have the ponds built over the spring, unless he wishes the fish to do their own spawning therein, when the old fish would be certain to eat their own babies as fast as hatched, as nature taught them to do.—*J. I. P., in Country Gentleman.*

THE BEAN—FABA VULGARIS.

By LOUISA REED STOWELL, M. S., Microscopical Laboratory, University of Michigan.

Bean.—Among the most common adulterations of wheat flour is found bean. It seems to be a favorite ingredient for mixing with a poor quality of flour, and the very small class of millers who are in the habit of selling compounds to the public under the name of wheat flour, use bean flour quite extensively. It is cheap, wholesome, easily obtained, and makes a tenacious dough. The botanical name of our common bean is *Faba vulgaris.* It belongs to the natural order *Leguminosæ*, and the sub-order *Papilionaceæ*. It has been cultivated in Asia and Europe since the earliest ages. It originated in the East, and is said to be still found wild in Persia. Although it dates from so ancient a time it is yet cultivated extensively over the whole world, and it is used for food in all countries for men, cattle, and swine. There are many different varieties cultivated and sold in market under various names, as Lima, kidney, Windsor, black-eyed beans, etc. The Lima bean is extensively cultivated in America, and furnishes an important article of diet.

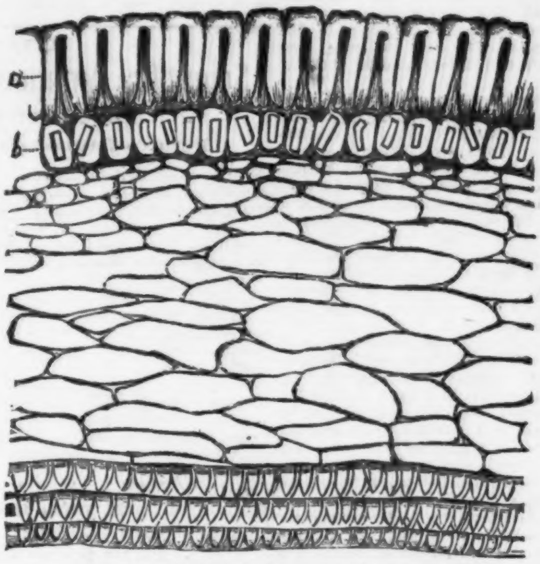


FIG. 7.—CROSS SECTION OF THE COATS OF BEAN.

Drawn with the Camera Lucida. Magnified 400 diameters.

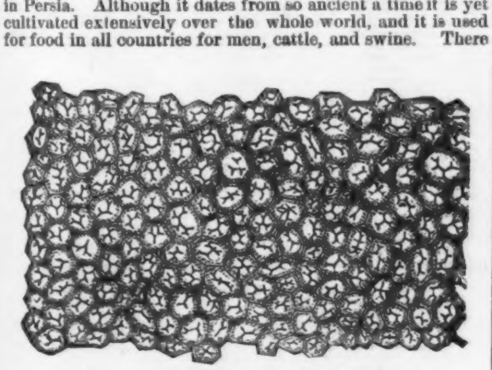


FIG. 8.—OUTER COAT OF BEAN.

Drawn with Camera Lucida. Magnified 475 diameters.

The common bean is either a running vine, trained on frames, bushes, or poles, or a bushy shrub growing one or two feet high. It has pinnate leaves, without tendrils, and fragrant flowers. The seeds, which are the nutritious food, are inclosed in long pods that are woolly on the inner surface. These pods, when green, and yet containing the soft green beans, are used for food. When fully ripe, the seeds are softened by soaking in water and then boiled or baked—baked beans having almost a world-wide reputation—or they are ground into a meal, thus making bean flour. The plant grows rapidly and luxuriantly, and it does not exhaust the soil, yet it requires a rich soil for its habitation. Beans are not cultivated to-day as extensively as they were before the introduction of turnips and clover. It is supposed by many that the common bean is much more nutritious than wheat. It contains a high proportion of nitrogenous matter, under the form of legumin. It is, on this account, rather a coarse food, and difficult of digestion, although it is regarded as the best of food for horses, even by many as far better than oats.

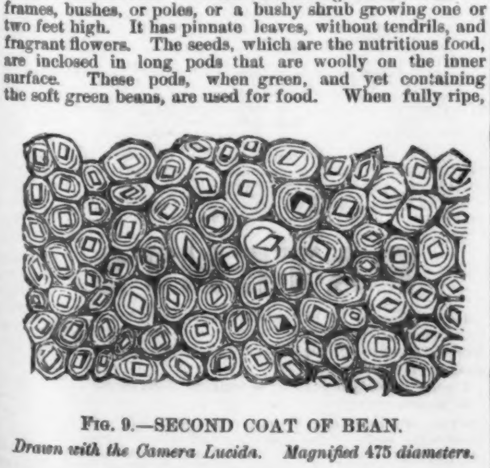


FIG. 9.—SECOND COAT OF BEAN.

Drawn with the Camera Lucida. Magnified 475 diameters.

The Greeks and Romans regarded beans with very great interest. They were used by them as ballots at the time of the election of magistrates. Among them a white bean signified the affirmative, and a black one the negative. Ovid gives a description of an important custom which existed among the ancients. He says: "Beans had a mystic use, for the master of the family, after washing his hands three times, threw black beans over his head nine times, continuing to repeat the words, 'I redeem myself and my family by these beans.'" Pythagoras urged abstinence from the use or contact of beans, and the Egyptian priests considered the sight even of beans to be unclean. Cicero used to maintain that beans were a great enemy to tranquillity of mind.

There are three distinct coats surrounding the bean. The outer seed coat, as seen at *a*, Figure 7, the middle seed coat seen at *b*, and the inner coat, consisting of all the remaining structure. The first, or outer coat, *a*, is made up of radically elongated cells, having somewhat the appearance of teeth. These central openings, that approach so near the top of the cell, are not of a uniform width, but are irregular, so if the section had been cut a trifle nearer either end of the bean, we should see some of the openings larger and some smaller than those seen in the illustration. The walls are thick, indicating a strong structure. The second or middle coat, *b*, is composed of thin-walled, nearly square cells, each cell containing a crystal. The crystals are of uniform shape and appearance, and standing up like sentinels in each cell. The third, or inner seed coat, consists of loosely packed, irregular, thin-walled cells. They are empty and collapsed, though they swell out when soaked in water. Below this layer, though forming a part of it, are found rows of beautiful spiral vessels.

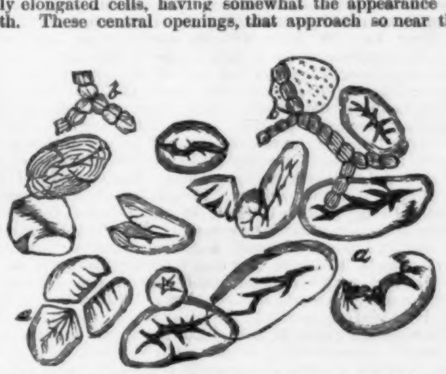


FIG. 10.—BEAN STARCH AFTER BEING BAKED AS IN BREAD.

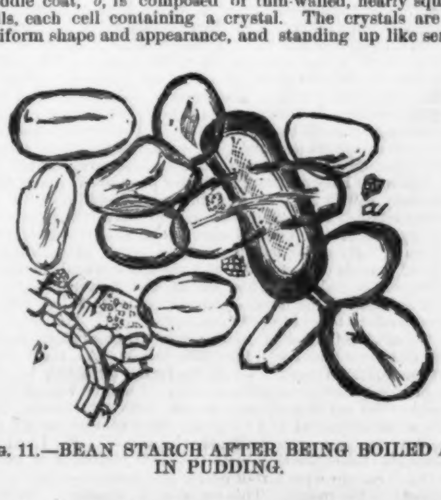


FIG. 11.—BEAN STARCH AFTER BEING BOILED AS IN PUDDING.

All of these different structures are found in a cross section of the very thin coat or skin that rubs off so easily from beans after they have soaked in water a few minutes. It is this same skin that shrivels up or wrinkles so when beans are first thrown in water. The way to secure a cross section for study under the microscope, is to take some of the thin skin from beans that have been soaking in water for several hours, and fold it together, so as to have four or more thicknesses, then place it between the smooth edges of elderberry pith and continue to cut very thin sections from the whole, until you have secured one so thin you can distinguish readily all of the different structures. A sharp razor will be needed for making the section.

If from the outside of a bean which has been soaking in water for several hours, the outermost part of the skin be picked or cut off with a razor, we can see the surface of the outer coat, as in Figure 8. The cells are now seen on the upper surface, and they are quite regular in size, surrounded with plane faces and angles, rather than being round, although they do not all have the same number of sides. Each cell is furnished with a central depression, and the center or lowest part of the depression seems to be a line broken abruptly, and the ends branching regularly, two at a time. This coat always presents a beautiful appearance under the microscope. It is almost impossible to separate the outer and middle coats—that is, *a* and *b* of Figure 7. So after examining the outer surface of the bean, Figure 8, if the little specimen we have on the glass slide be turned over, we shall see the surface of the middle coat, as seen in Figure 9. This coat is composed of a single row of thin-walled cells, each containing its sentinel crystal.

FIG. 12.—CELLS OF BEANS LOADED WITH STARCH AND GLUTEN.

Magnified 475 diameters. Drawn with Camera Lucida.

The starch grains of bean are of particular interest, for they contain characteristics peculiar to themselves—see Figures 10 and 11. The starch grains are oval or round, very similar in shape to the beans themselves. Then there is a central line or mark through the grain, corresponding to the mark on the back of the bean where it is attached to the pod. This line is ragged and uneven in shape, though it marks the nucleus. So great is the resemblance to beans that persons in looking at the starch seem to think they are looking through a glass dimly at the beans themselves. Near the edge of the starch grain, but seldom extending to the center, are seen dark rings, quite fine and numerous. The grains average $\frac{1}{800}$ of an inch in length, and $\frac{1}{1000}$ of an inch in width.

When the starch grains of bean are subjected to a high degree of heat, but with no moisture present, the grains become brittle, and the nucleus is destroyed; the rings are not affected, but the edge becomes broken and ragged. Bean flour will seldom be subjected to an intense dry heat. In all kinds of baking, and in the treatment of the flour wherever heat is used, there is more or less moisture accompanying it. Where there is an extreme moist heat there is a great change produced in the starch, but not enough to destroy its identity. A microscopist can detect the presence of bean starch when mixed with wheat, even after it has been baked into bread. Figure 10 gives us the appearance of bean starch after it has been baked. The moisture of the dough has caused the grains to expand slightly, while the heat has rendered them brittle and ragged. The nucleus and rings are slightly affected. At *b* some of the cellular structure appears.

In Figure 11 we have some of the starch grains after they have been boiled in a pudding. They show very little resemblance to the original grain, yet it is sufficient when you see a large quantity of the grains to identify them. They have swollen to an enormous size, have lost their rings, though they retain their nucleus as well as their general shape. At *b*, can be seen how great a change is produced in the wall of cellulose by boiling. It would be impossible with any one starch grain, or with even a small number, to tell definitely just what treatment the starch grain has undergone. It is only when you examine a large quantity, and even then you can not tell the extent of the baking or the boiling by its appearance under the microscope. The entire bean, after the thin skin is removed, consists of large cells loaded with starch and gluten. (See Figure 12.) The cells are generally hexagonal, thick-walled, and quite large. There are only a few starch grains contained in each cell, as compared with the way the starch grains of wheat are packed in their cells. Lying close to the walls and filling up all the space between the starch grains are the fine granules of gluten.

A microscopical examination of bean flour reveals all of the structures represented in the illustrations, and they are so different from the structures found in wheat, as to be easily identified. Nitric acid forms an important test for the presence of bean flour. Whenever wheat flour with which powdered beans are mixed is brought in contact with nitric acid and ammonia, it immediately assumes a deep red color. The presence of bean flour, when mixed with wheat flour, may be detected generally by the peculiarly strong odor of beans, and by the darker or yellowish gray color which the wheat flour assumes.—*American Miller.*

IT is estimated that the coal fields of India extend over an area of 35,000 square miles. Some of the seams are 100, 120, and 160 feet thick. Dr. Oldham believes there are not less than 20,000,000,000 tons of coal in that empire.

GESTATION OF DOMESTIC ANIMALS.

THE variations of the period of gestation in different animals, and in the same species under different circumstances, are of great interest, not only to the physiologist, but to the breeder, as well as to your correspondent who inquires about it. As might be expected, the duration of pregnancy in species that will hybridize, as for instance the horse and the ass, the cow and the buffalo, the sheep and the goat, is very nearly the same, and it might be readily considered that the crossing would be impossible were it otherwise. The periods are remarkably irregular, and this irregularity is sometimes so great as to lead to disputes and misunderstandings, as when the variation is greater than the time of the recurrence of the period of heat, and it may sometimes be readily supposed that the service which produced the pregnancy might have been ineffective, and some other unnoticed connection might have taken place. Thus the minimum and maximum periods here given will be seen to exhibit unexpected variations:

PERIODS OF GESTATION.

	Days.	Average.
In the mare	300 to 400	340
" cow	220 to 320	280
" sheep and goat	143 to 156	150
" pig	104 to 127	120
" dog	55 to 70	63
" cat	50 to 64	55
" rabbit	28 to 30	30

These periods vary with individuals and with breeds; with the sex of the offspring, the age of the dam and her strength and condition. It also varies because of the length of the season of heat, for this may continue for several days, and impregnation may occur some time after service, when the ovule passes through the Fallopian tube. This passage requires four to five days in the cow and sheep, and eight to ten days in the dog.

Some animals always carry their young for an abnormal period, either shorter or longer, and this habit becomes characteristic with them. The Dutch cows are said to be more regular and to keep closer to the average period of 280 days than other breeds. A mare served by a thoroughbred horse will go longer with foal than one served by a cold-blooded horse, and a mare goes longer with a mule colt than with a horse colt; but precisely what this difference amounts to is not yet sufficiently established. The average period of gestation in the mare is 340 days. Recorded periods in 284 cases mentioned by Fleming in his Veterinary Obstetrics, give 307 days for the shortest and 394 days for the longest period—a mean of 346 days. In 25 cases noted at the stud at Pin, in France, the shortest time was 324 and the longest 367 days, the mean being 343 days. Baumeister states that the periods of pure bred Persian mares were 338 days for mare foals and 343 days for horse foals; in pure bred Arabs they were 337 and 339 days for female and male foals respectively; in Orloff mares the average period was 341½ days, and in half bred English mares it was 339½ days. The majority of foals are born from the 34 th to the 350th day; living foals are rarely born from the 300th to the 310th day; but frequently from the 350th to the 365th day. After the latter period a live birth is rare. I have, however, known of two cases the present year in which the foals were carried several days longer than 12 months, and in each case there was a dispute as to the accuracy of the record by the owners, who wished to escape payment of the service fee, they disbelieving the possibility of so long a period. The longest period of the mare's gestation known is given by Dieterichs as 419 days.

In 34 cases recorded at an English thoroughbred stud, the following periods were noted in 1876:

	Period of	316 days.
	do.	318
5	do.	320 to 330
11	do.	330 to 340
15	do.	340 to 348
1	do.	354
	Average	335¼
17 colts averaged		336½
17 fillies	do.	334

The shortest and the longest periods, viz., 316 to 318 days, and 348 to 354 days, were with fillies. These shorter periods were with mares nineteen years old, and the longer with mares nine years old. Nevertheless the records do not show that the period is affected by age, for instance:

		Average days.
3 five-year-old mares went		340
2 six	do.	350½
3 seven	do.	328⅔
2 nine	do.	340½
2 ten	do.	336
6 twelve	do.	337
4 fourteen	do.	336⅓
5 fifteen	do.	333
2 sixteen	do.	340½
1 seventeen	do.	324
1 eighteen	do.	330
3 nineteen	do.	325

It has been generally the case that the periods of gestation are shortened by the more favorable physical conditions prevailing in high-bred studs, where the keeping and the vigor are of the highest character.

The period of the ass is always somewhat longer than that of the mare.

In cows the periods vary quite as much as in mares. In a French agricultural school, of 1,062 observations, 15 periods were less than 241 days, 52 from 241 to 270 days, 119 from 271 to 280, 230 from 281 to 290, 70 from 290 to 300, and 32 longer than 301 days; 544 periods were from 271 to 300 days. The average is 283 days. The shortest known period is 210 days and the longest 353. The average period of the Swiss cows is known to be 280½ days—that of bull calves being 283 days and of cow calves 278 days. In 764 observations made by Earl Spencer with high-bred Shorthorns, no live calf was produced before the 220th or after the 313th day, and all born before the 242d day died in the attempt to rear them. The average time was 284 days. The majority of the calves dropped after the 290th day were bulls.

The *American Journal of the Medical Sciences* records as the results of 63 observations, that the shortest period was 213, and the longest 336 days; the average for cow calves was 282 days, and that for bulls 288 days. In my own herd the past two years of 30 births, 6 were from 270 to 278 days, 22 from 280 to 288 days, and 2 were 291 and 292 days. The 9 longest periods, viz., from 286 to 292 days, were all bull calves. The shortest periods, 270 and 272 days, were with a pure Dutch cow, and the longest with a pure Ayrshire; this cow went 291 days last year, and 292 days this year.

The average period of the sheep is 149 to 150 days. The Southdown goes 144 days only, as a rule, and the Merinos 150 days. This difference has been widely observed. Parturition may take place in the ewe from the 145th to the 160th day. The male lambs occupy the longer period. In my own flock, consisting of natives, with half-bred and thoroughbred Cotswolds, in five years' records, viz., from 1865 to 1870, the periods were remarkably regular, with those sheep whose time of service was accurately noted, and these were nearly all of a flock of from 50 to 70; the shortest time on record is 148 days, and the longest 156 days. In 1870, of 65 lambs, 35 were dropped on the 150th day. One ewe brought a pair of very large lambs on the 156th day, but this was a case of difficult parturition, as the ewe had been chased by a dog some time previously, and was very weak and required assistance. M. Magne mentions 429 cases in which the periods were from 143 to 156 days; of these, 329 were from 147 to 151 days, and only 3 went as long as 156 days. The sheep, therefore, possesses a much more regular period of gestation than the larger animals. The period of the goat is said to be somewhat longer than that of the ewe; 153 days, or five months, is given by Mr. Holmes in his book on the goat. The only two cases personally known to me are both of 154 days, and in both the kids were males.

The time of the pig is considered as four months (120 days), or, as fancifully held by some, as three months three weeks and three days. Authorities give many observations in which the periods have been from 109 to 133 days, and the average from 116 to 120 days. In 65 cases noted by Rainard and mentioned by Fleming, 2 were 104 days, 10 from 110 to 115 days, 50 from 115 to 125 days, and 3 from 126 to 127 days. The average is 119 days. In my own records for several years the periods have been exactly 120 days in every instance but two, and in both of these the pigs died. The dog's period has been noted as from 58 to 65 days. Baumeister states the extremes to be 55 to 70 days, the average being 60 days. Other observers fix the average as 63 days, or the popular period of 9 weeks. The cat goes 8 weeks on the average, the extreme periods noted being 50 to 64 days. The rabbit's period is 30 days, and this animal is extremely regular in its period. As this subject is not without interest in regard to the effect of breeding and culture upon domestic animals, as instanced by the highly bred and carefully cultured and vigorous, sturdy Southdown, it might be suggested that records be kept by those patient, persevering, and observing breeders who confine their attention to one breed, one system of management, and a careful culture of their favorite flocks and herds. Accumulated facts become the heritage of history, and students of agricultural science are often led to deplore the want of authentic materials in sufficient quantity and variety to be completely satisfactory. Such records are the work of lifetimes of individuals; but institutions remain while persons die, and those at least should accumulate such records as these.—*H. Stewart, in Country Gentleman.*

ENSILAGE FODDER.

A CORRESPONDENT of the *Country Gentleman* says: Doubtless Mr. Bailey's statements are well meant, but they are certainly calculated to mislead persons into supposing that nothing can be done without costly stone structures. For those who have the money to spend there cannot be the least objection to the carrying out of his suggestions and plans; but few *farmers* are able to do this, and must try some inexpensive methods. Now there are such methods that may be put in practice, notwithstanding Mr. Bailey thinks nothing but a masonry silo will answer the purpose. I have been looking over my file of that excellent paper, the *Journal d'Agriculture Pratique*, and in August, 1876, I find an account of a silo made by a French farmer in all respects similar to that described by me in the *Country Gentleman* (page 419), as in use thirty years ago. If this kind of silo can be used in France, Germany, and other parts of Europe, it surely can be used here, and may be made available, as an experiment, with little trouble and cost the present season, while a more elaborate one could not. Mons. J. Lartique, St. Paul-les-Dax, writes to the paper referred to as follows: "In September (3 to 5), 1875, I harvested, cut, and ensilaged 25,000 kilogrammes (2¼ pounds each) of maize. The cost of these operations were 57 francs (20 cents each), or nearly 2¼ francs per 1,000 kilos. (This is nearly equal to 45 cents per ton, but labor is very cheap in France.) The yield of my soil was 30,000 kilos per hectare (2·4 acres each, and nearly equivalent to 30 tons per acre.) The cost of the crops was 250 francs per hectare. It is only some years that I obtain this favorable yield from my soil.

"My silo consists of a simple trench in the soil, which is a slightly compact clay. It measured 2 meters (6 ft. 6 in.) in width, the same in depth, and 20 meters (65 ft. about) in length. The bottom was covered with a layer of furze. The maize was cut in pieces from three-quarters of an inch to one inch long, and was covered with a layer of the furze and then with earth to a depth of 24 to 32 inches. The earth was beaten hard and disposed of in the form of a 'hog's back.' This was my silo. I opened my silo the first of January following. The forage was yellow, and it gave a strong but agreeable alcoholic odor. Some of the cows ate the fodder at once; others hesitated, but took it after two hours. After eight days all ate it with avidity and preferred it to the best hay. I found that the fodder pleased my cows; that they thrived well upon it; and that the yield of milk increased while it was fed, and decreased when it was finished and hay was given. The pigs ate it with avidity and thrived well on it. My cows had been in the habit of consuming 18 to 22 pounds of hay daily, and they consumed 36 to 56 pounds of the fodder. They are of the Breton breed and small animals. One hundred kilos (224 pounds) of fodder are equivalent to 40 kilos (90 pounds) of hay. The result of the use of 25,000 kilos of fodder was to economize 10,000 kilos of hay, which I sold for 1,200 francs. As the fodder cost me but 250 francs, I saved 950 francs (or $190) by the use of this quantity of land, the crop of which was so preserved. For me to feed hay at this price is ruinous, but with maize ensilaged at 1 franc the 100 kilos (about $2 per ton) dairying is a very profitable business." M. Lartique relates also his experience with the same treatment of sweet potatoes, cut up with a root-cutter and preserved in a silo precisely as the maize. This was done in January. In July the silos were opened, and their contents were found in a perfect condition and were fed to pigs which ate them eagerly.

On the same pages I find a statement by Mons. P. Berland, of Corcelles, who ensilaged ten tons of green lucerne in October, in a silo made only 13 inches deep, on account of the wet condition of the ground. The lucerne was trodden whole in the trench, and heaped above the surface. It was covered with a paste of wet clay first, about one inch thick, and then with earth 14 inches thick. This was opened two months later, and found to be only slightly changed in color and in good order. Seventy-five tons of green clover were also preserved in a silo 28 inches deep, 11½ feet wide, the clover being heaped above the surface for nine feet. This was covered in the same manner, and was taken out in good condition, but brown in color. This gentleman states that he has preserved whole cornstalks and beet leaves for some years, in the same manner. He considers the practice a most valuable one, as it entirely relieves him from dependence on the weather and loss of time when he would be curing his fodder for hay; it also enables him to preserve the latest grown crops in the best manner. He has fed for some years 90 head of stock on 15 acres of beet leaves thus preserved, for a considerable length of time.

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